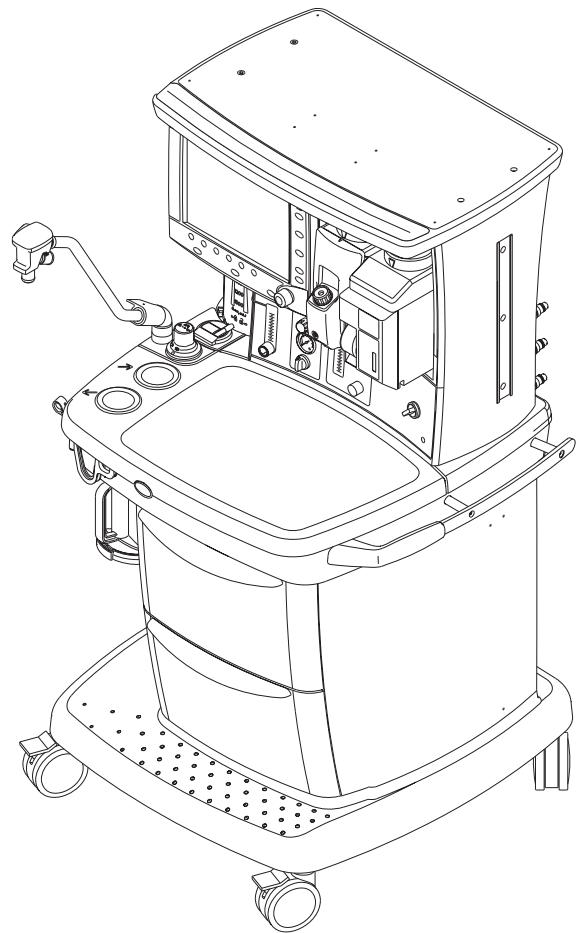


# **S/5 Avance Anesthesia Machine**

## Technical Reference Manual



Datex-Ohmeda products have unit serial numbers with coded logic which indicates a product group code, the year of manufacture and a sequential unit number for identification.

AAA F 12345

This alpha character indicates the year of product manufacture  
and when the serial number was assigned;  
“D” = 2000, “E” = 2001, “F” = 2002, etc.  
“I” and “O” are not used.



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## **S/5 Avance Anesthesia Machine**

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## Important

The information contained in this Technical Reference manual pertains only to those models of products which are marketed by Datex-Ohmeda as of the effective date of this manual or the latest revision thereof. This Technical Reference manual was prepared for exclusive use by Datex-Ohmeda service personnel in light of their training and experience as well as the availability to them of parts, proper tools and test equipment. Consequently, Datex-Ohmeda provides this Technical Reference manual to its customers purely as a business convenience and for the customer's general information only without warranty of the results with respect to any application of such information. Furthermore, because of the wide variety of circumstances under which maintenance and repair activities may be performed and the unique nature of each individual's own experience, capacity, and qualifications, the fact that customer has received such information from Datex-Ohmeda does not imply in anyway that Datex-Ohmeda deems said individual to be qualified to perform any such maintenance or repair service. Moreover, it should not be assumed that every acceptable test and safety procedure or method, precaution, tool, equipment or device is referred to within, or that abnormal or unusual circumstances, may not warrant or suggest different or additional procedures or requirements.

This manual is subject to periodic review, update and revision. Customers are cautioned to obtain and consult the latest revision before undertaking any service of the equipment. Comments and suggestions on this manual are invited from our customers. Send your comments and suggestions to the Manager of Technical Communications, Datex-Ohmeda, Ohmeda Drive, PO Box 7550, Madison, Wisconsin 53707.

### ⚠ CAUTION

Servicing of this product in accordance with this Technical Reference manual should never be undertaken in the absence of proper tools, test equipment and the most recent revision to this service manual which is clearly and thoroughly understood.

## Technical Competence

The procedures described in this Technical Reference manual should be performed by trained and authorized personnel only. Maintenance should only be undertaken by competent individuals who have a general knowledge of and experience with devices of this nature. No repairs should ever be undertaken or attempted by anyone not having such qualifications.

Datex-Ohmeda strongly recommends using only genuine replacement parts, manufactured or sold by Datex-Ohmeda for all repair parts replacements.

Read completely through each step in every procedure before starting the procedure; any exceptions may result in a failure to properly and safely complete the attempted procedure.

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# 1 Introduction

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## 1.1 What this manual includes

This manual covers the service information for the S/5 Avance line of anesthesia machines. It covers the following components:

- Display Unit
- Integral electronics
- Gas delivery components
- Breathing system components
- Frame component
- Optional suction regulator
- Optional auxiliary O<sub>2</sub> flowmeter

### Other equipment

Other equipment may be attached to the system on a display mount, the top shelf, or on the side dovetail rails. Consult separate documentation relative to these items for details.

## 1.2 User's Reference manuals

Some sections of this manual refer you to the User's Reference manual for the S/5 Avance. To expedite repairs, you must have, and be familiar with, the User's Reference manuals for this product.

Refer to the S/5 Avance User's Reference manual if you need further information about the operation of the system.

## 1.3 What is an S/5 Avance anesthesia machine?

The S/5 Avance anesthesia machine is a compact, integrated, and intuitive anesthesia delivery system. It provides electronic gas mixing and optional integrated respiratory gas monitoring.

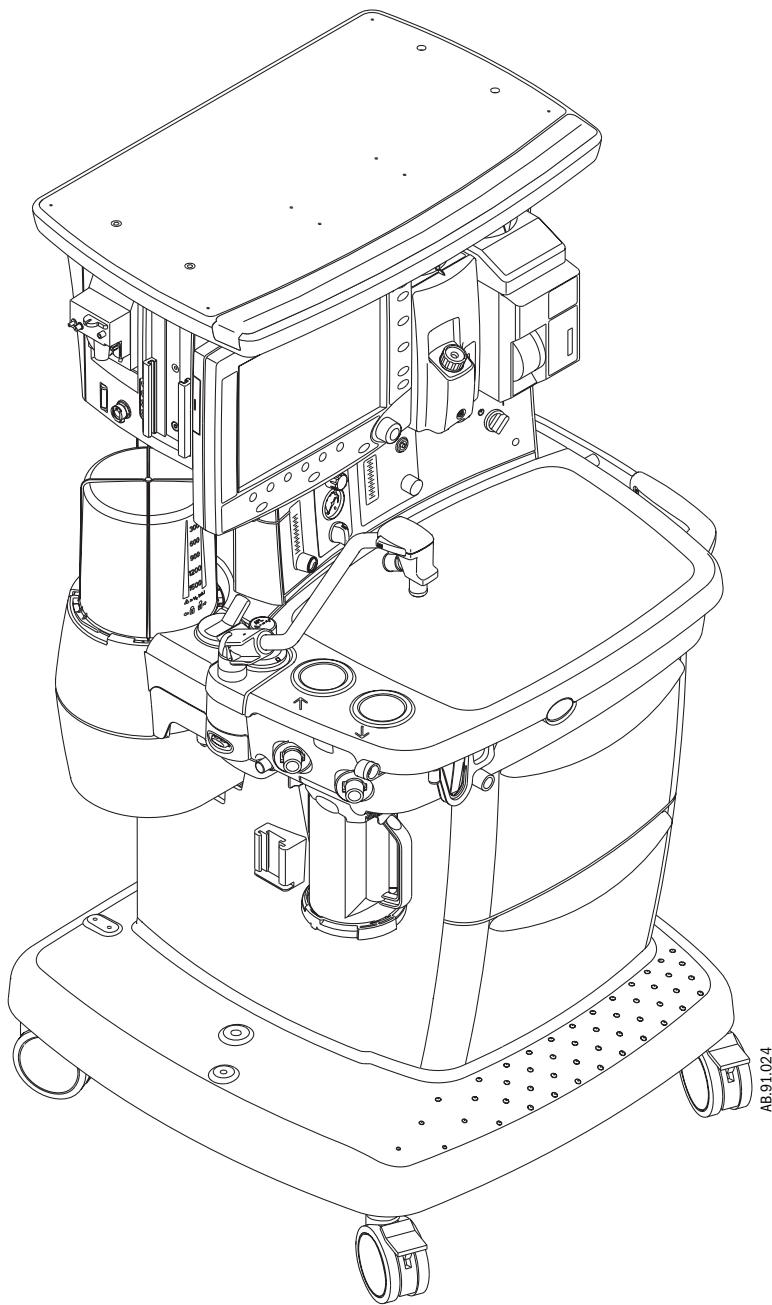
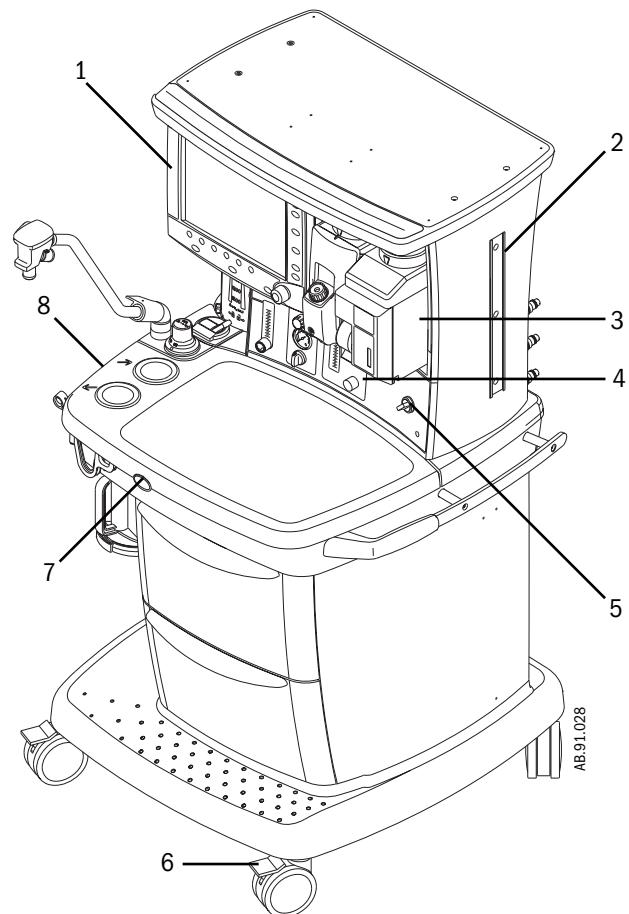


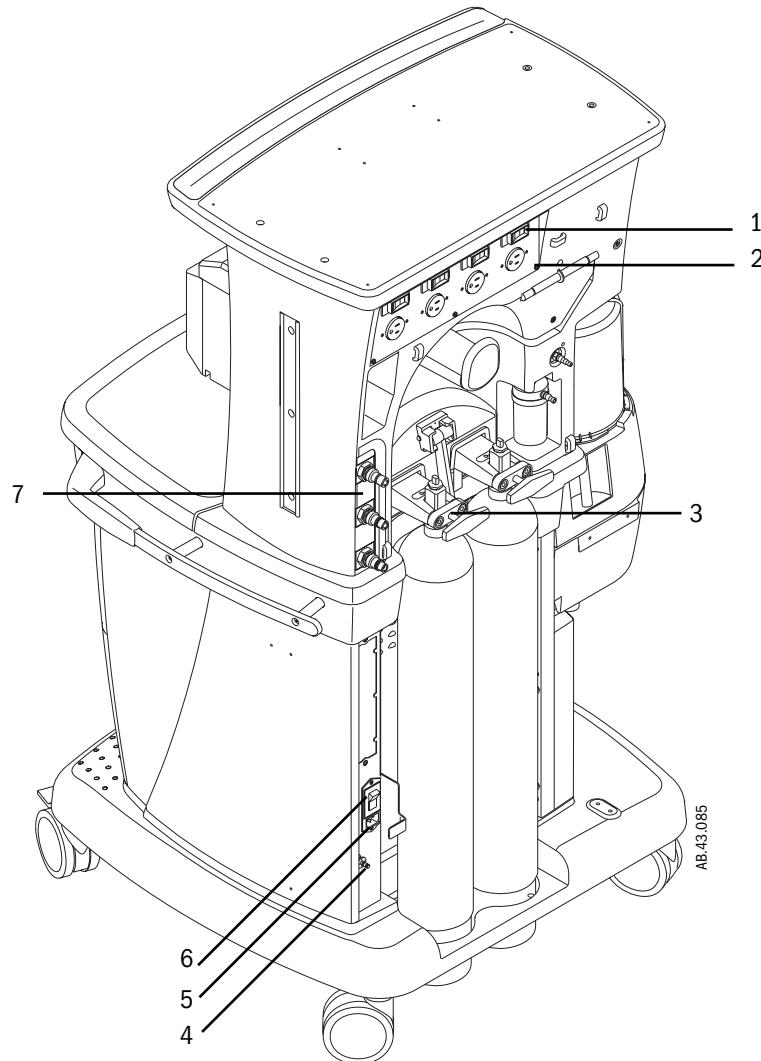
Figure 1-1 ▪ S/5 Avance system

## 1.4 Anesthesia system components



1. Anesthesia system display
2. Dovetail rails
3. Vaporizer
4. Alternate O<sub>2</sub>
5. System switch
6. Brake
7. O<sub>2</sub> flush button
8. Breathing system

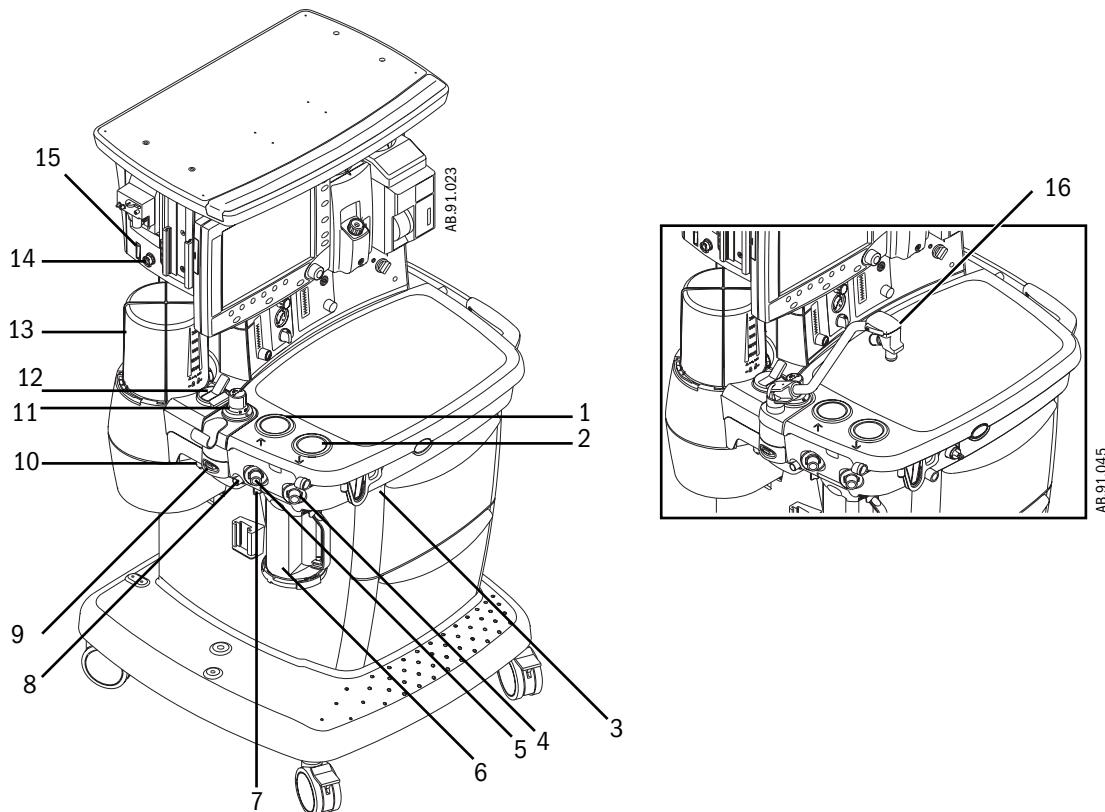
Figure 1-2 • Front view



1. Outlet Circuit breaker (optional)
2. Electrical outlet (optional)
3. Cylinders supplies
4. Equipotential stud
5. Mains inlet
6. System circuit breaker
7. Pipeline connections

Figure 1-3 • Rear view

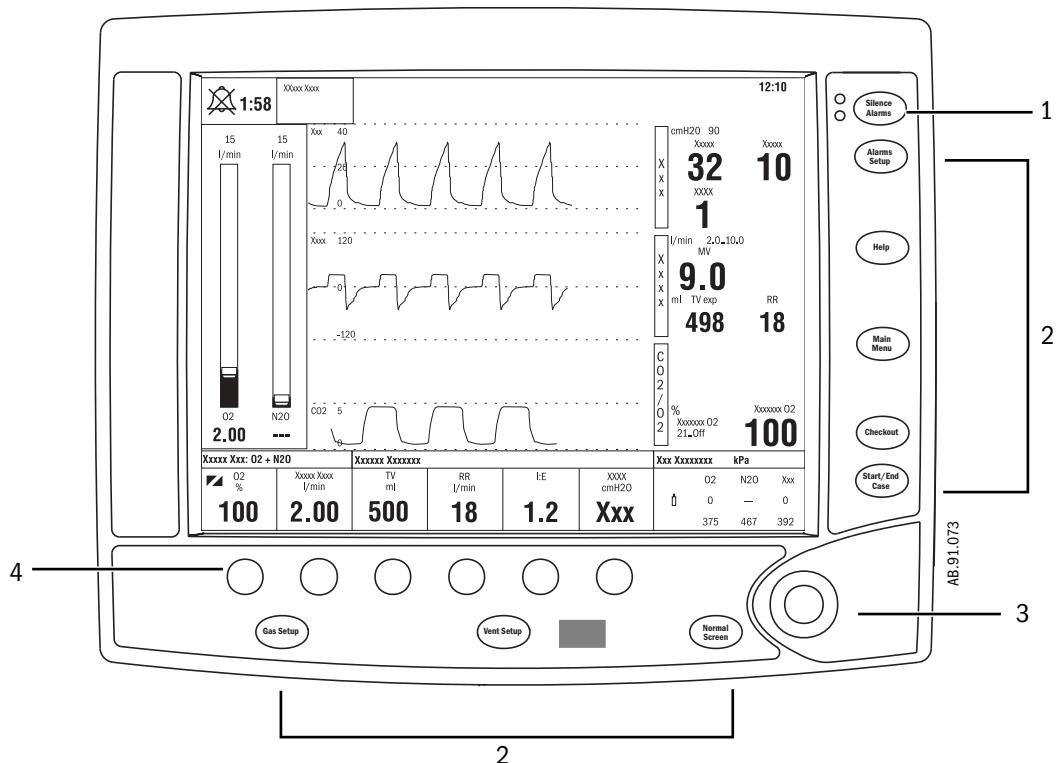
## 1.5 Breathing system components



1. Expiratory check valve
2. Inspiratory check valve
3. ACGO (optional)
4. Inspiratory flow sensor
5. Expiratory flow sensor
6. Absorber canister
7. Absorber canister release
8. Leak test plug
9. Breathing system release
10. Manual bag port
11. Adjustable pressure-limiting (APL) valve
12. Bag/mechanical ventilation switch
13. Bellows assembly
14. Sample gas return port
15. AGSS indicator (only available on some AGSS versions)
16. Bag support arm (optional)

Figure 1-4 • Breathing system

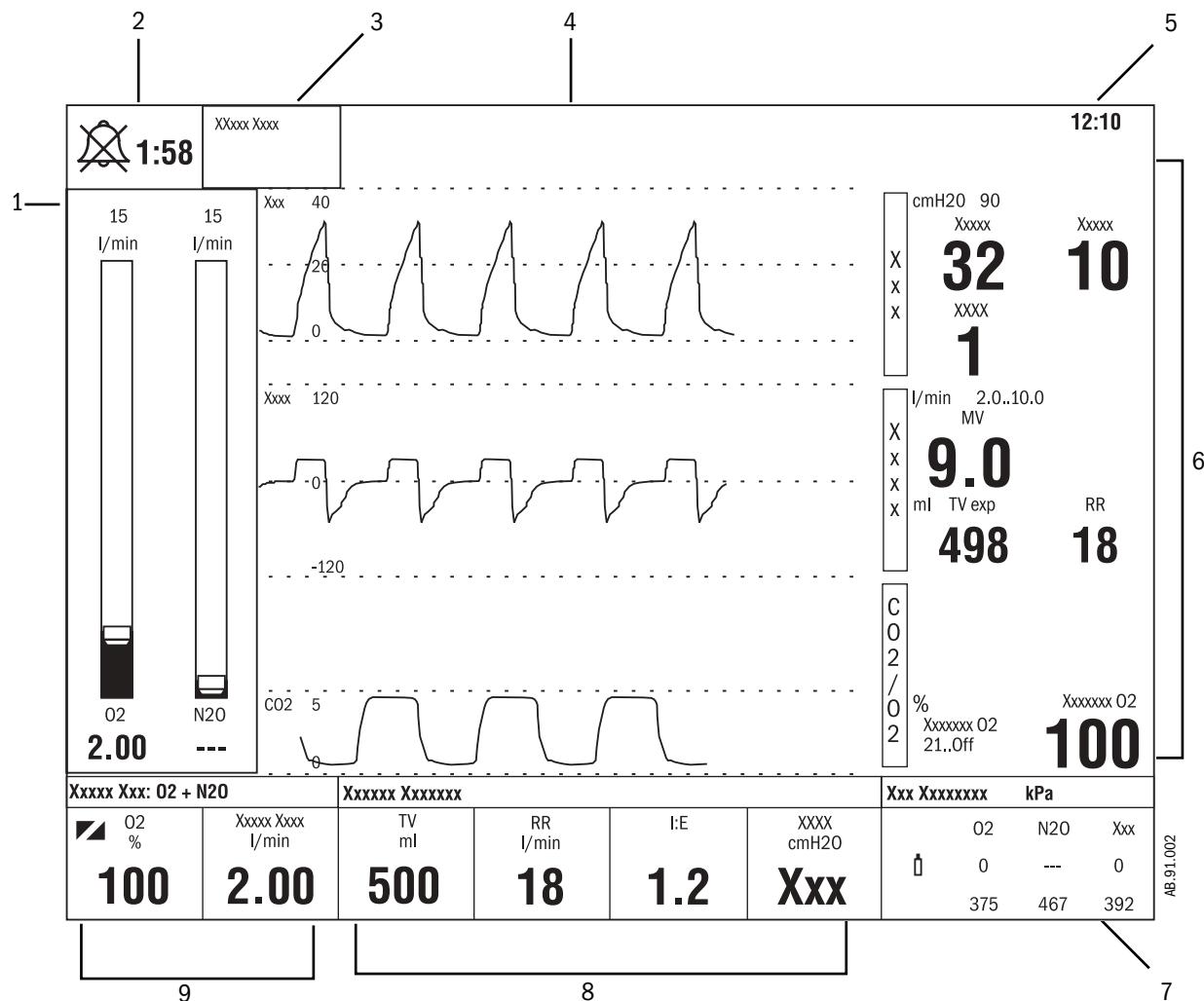
## 1.6 Display controls



Item	Description
1 Alarm silence key	Push to silence any active, silenceable high and medium priority alarms. Alarm is silenced for 120 seconds.
2 Menu keys	Push to show corresponding menu.
3 ComWheel	Push to select a menu item or confirm a setting. Turn right or left to scroll menu items or change settings.
4 Quick keys	Push to change corresponding gas setting or vent setting. Use the ComWheel to make a change. Push the ComWheel to activate the change.

Figure 1-5 • Ventilator controls

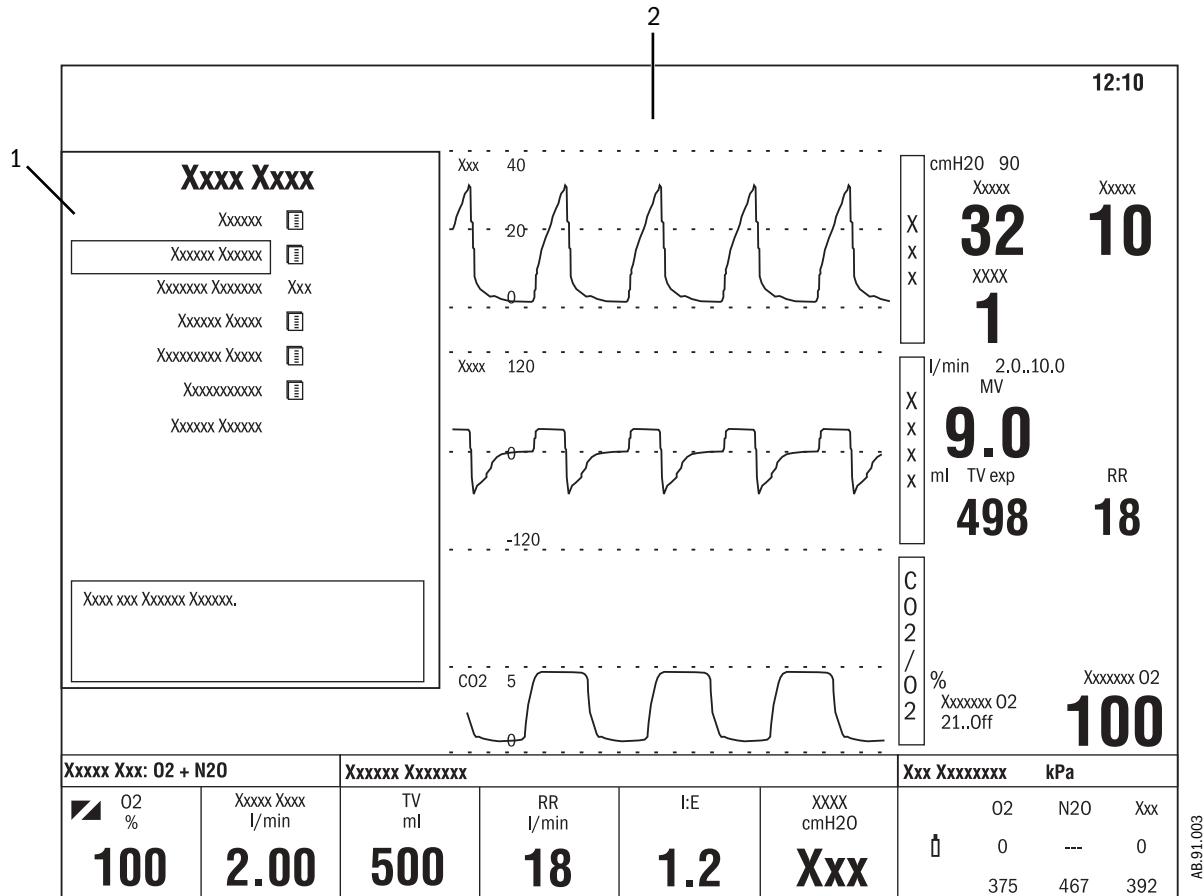
## 1.7 Anesthesia system display



1. Electronic gas flow tubes
2. Alarm silence countdown
3. Alarm message fields
4. Waveform field
5. Clock
6. Number field
7. Free number display
8. Ventilator settings
9. Gas settings

Figure 1-6 • Normal view

When a menu key is selected, the menu field overlays the gas flow tubes and the waveform fields start at the right edge of the menu.

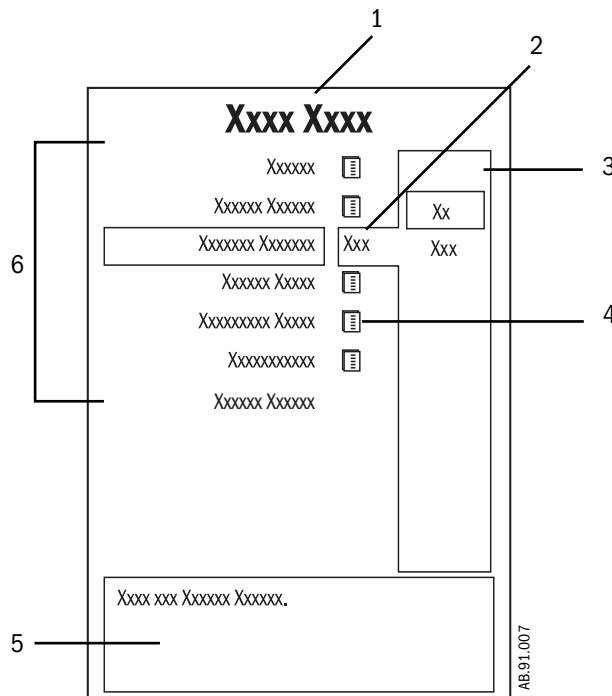


1. Menu
2. Waveform fields

Figure 1-7 • Menu view

### 1.7.1 Using menus

Push a menu key to display the corresponding menu. Use the ComWheel to navigate through the menu.



1. Menu title
2. Present selection
3. Adjustment window
4. Indicates submenu
5. Short instructions
6. Menu selections

Figure 1-8 • Example menu

1. Push the menu key to display the corresponding menu.
2. Turn the ComWheel counterclockwise to highlight the next menu item. (Turn the ComWheel clockwise to highlight the previous menu item.)
3. Push the ComWheel to enter the adjustment window or a submenu.
4. Turn the ComWheel clockwise or counterclockwise to highlight the desired selection.
5. Push the ComWheel to confirm the selection.
6. Select **Normal Screen** or push the **Normal Screen** key to exit the menu and return to the normal monitoring display. (Select **Previous Menu** to return to the last displayed menu, if available.)

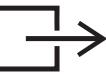
## 1.8 Symbols used in the manual or on the equipment

 Warnings and  Cautions tell you about dangerous conditions that can occur if you do not follow all instructions in this manual.

Warnings tell about a condition that can cause injury to the operator or the patient.

Cautions tell about a condition that can cause damage to the equipment. Read and follow all warnings and cautions.

Other symbols replace words on the equipment or in Datex-Ohmeda manuals. No one device or manual uses all of the symbols. These symbols include:

	On (power)		Alarm silence button
	Off (power)		Alarm silence touch key (Tec 6).
	Standby		Type B equipment
	Standby or preparatory state for part of the equipment		Type BF equipment
	"ON" only for part of the equipment		Type CF equipment
	"OFF" only for part of the equipment		Caution, ISO 7000-0434
	Direct current		Attention, refer to product instructions, IEC 60601-1
	Alternating current		Dangerous voltage
	Protective earth ground		Electrical input
	Earth ground		Electrical output
	Frame or chassis ground		Pneumatic input
	Equipotential		Pneumatic output

	Plus, positive polarity		Movement in one direction
	Minus, negative polarity		Movement in two directions
	Variability		Read top of float
	Variability in steps		Vacuum inlet
	This way up		Suction bottle outlet
	Lamp, lighting, illumination		Cylinder
	Lock		Isolation transformer
	Unlock		Linkage system
	Close drain		Risk of Explosion.
	Open drain (remove liquid)		Low pressure leak test
<b>134°C</b>	Autoclavable		Mechanical ventilation
	Not autoclavable		Bag position/ manual ventilation
Insp	Inspiratory flow	Exp	Expiratory flow
<b>O<sub>2</sub>%</b>	O <sub>2</sub> sensor connection	<b>O<sub>2</sub>+</b>	O <sub>2</sub> Flush button
<b>REF</b>	Stock Number	<b>SN</b>	Serial Number



Alarm silence touch key



Volume alarms On/Off touch key



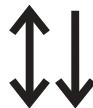
End case touch key



Menu touch key



Circle breathing circuit module



Bain/Mapleson D breathing circuit module



The primary regulator is set to pressure less than 345 kPa (50 psi)



The primary regulator is set to pressure less than 414 kPa (60 psi)



Absorber on

CO<sub>2</sub> Bypass OptionAbsorber off (CO<sub>2</sub> Bypass active)

Systems with this mark agree with the European Council Directive (93/42/EEC) for Medical Devices when they are used as specified in their User's Reference manuals. The xxxx is the certification number of the Notified Body used by Datex-Ohmeda's Quality Systems.



CE European Union Representative

## Notes

## 2 Theory of Operation

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## 2.1 Electrical system

The electrical system consists of two main computing units: the Display Unit and the Anesthesia Control board. Additional subsystems interact with these computing hosts to perform various gas delivery, ventilation, and monitoring functions.

The Display Unit handles the main user interface functions and connections to external devices. The Display Unit software runs on the Windows CE operating system.

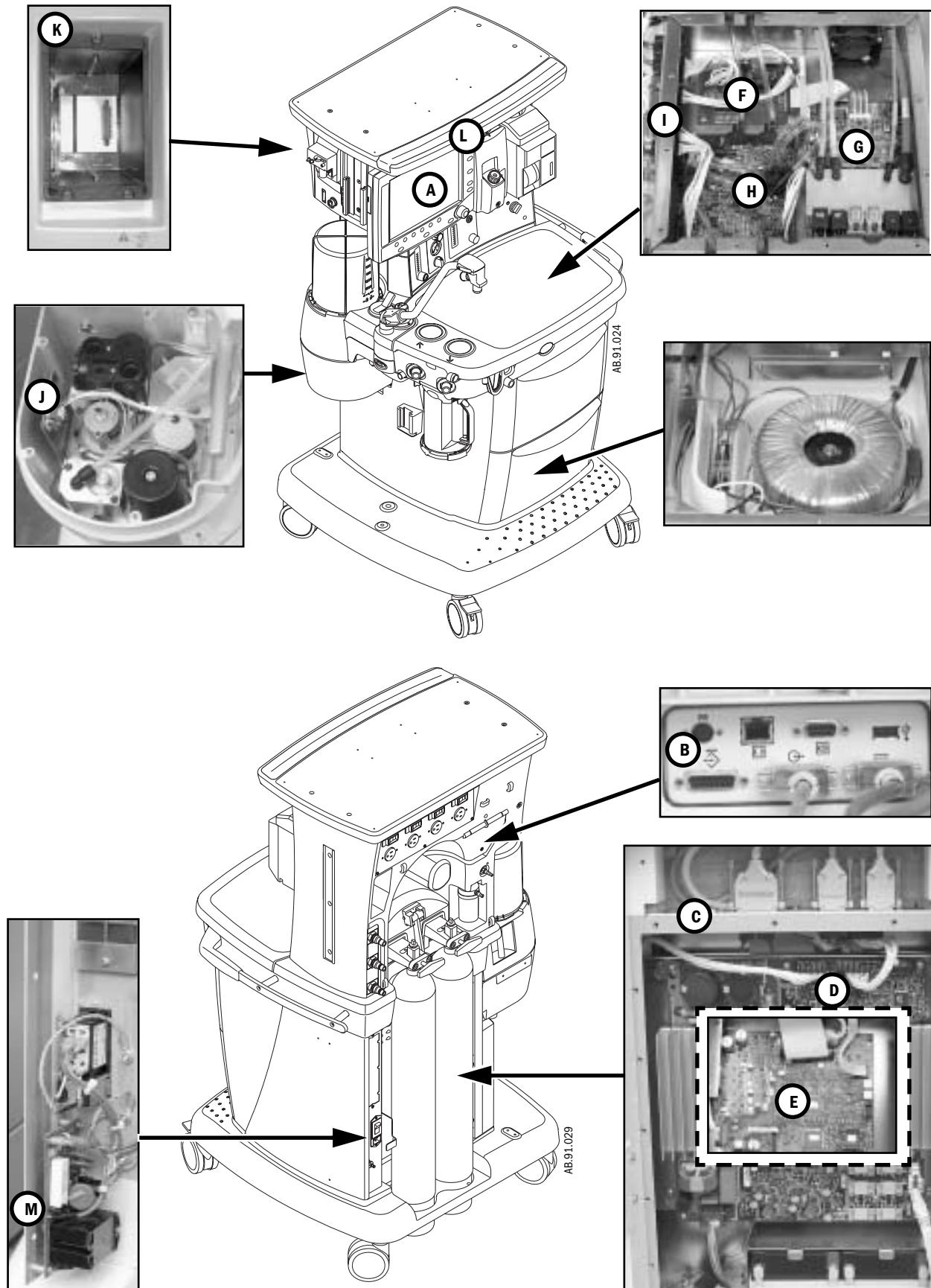
Therapy functions are handled by the Anesthesia Control board. The Anesthesia Control board is based on the Motorola Coldfire processor with a Nucleus operating system.

Embedded controllers are used to perform specific machine functions on subsystems like the Power Controller board and the Mixer board.

The processors communicate through serial bus channels.

The various functions of the electrical system are accomplished on the following circuit boards:

- Display Unit CPU (**A**)
- Display Unit System Interconnect assembly (**B**)
- Display Connector board (**C**)
- Power Controller board (**D**)
- Anesthesia Control board (**E**)
- Pan Connector board (**F**)
- Electronic Mixer board (**G**)
- Ventilator Interface board (**H**)
- ABS Filter board (**I**)
- Vent Engine Connector board (**J**)
- MGAS Power Supply board (**K**)
- Light Strip board (**L**)
- Inrush board (**M**)



## 2.2 Power subsystem

Mains power enters the system through the AC Inlet module (**A**), which includes a line filter and the system circuit breaker. Mains power is routed through the Inrush (**B**) circuit board to the isolation transformer (**C**).

The isolated secondary output of the transformer is routed through fuses (**D**) and a second line filter (**E**) to the input of the Power Controller board (**F**). If the system is equipped with electrical power outlets, the transformer (larger size) also supplies isolated power to the electrical outlets through individual circuit breakers.

The Power Controller board interfaces with the system through:

- the Anesthesia Control board connector (**G**),
- the Display Connector board connector (**H**),
- the battery connector (**I**) and fan connector (**J**).

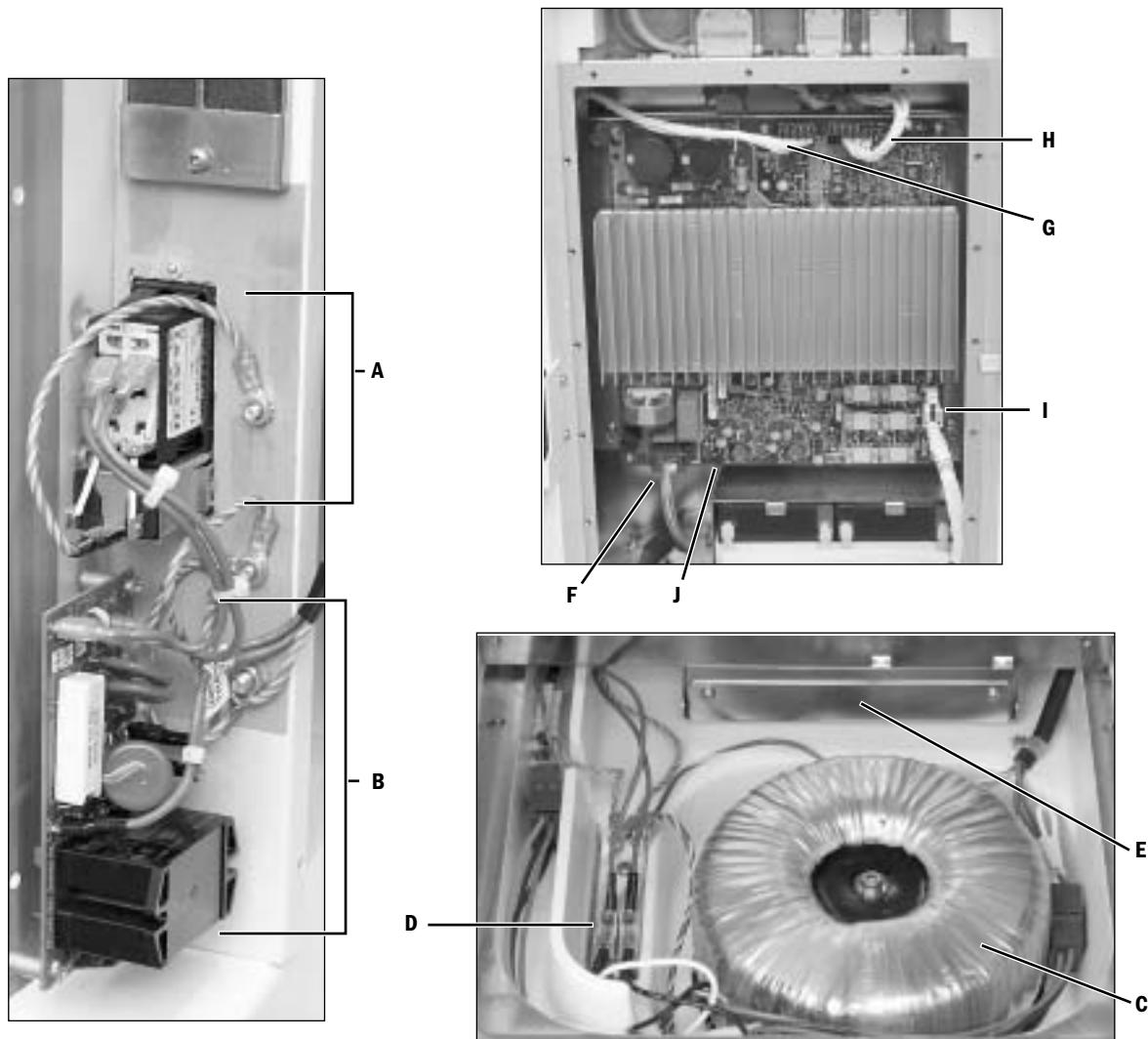


Figure 2-9 • Power subsystem

## 2.2.1 Power Controller board

The system uses a distributed power bus. The Power Controller board contains:

- an AC/DC converter that converts line voltage to high voltage DC.
- a DC/DC converter that converts the high voltage DC to battery voltage.
- a DC/DC converter that converts battery voltage to the 12.5 VDC system bus voltage.

The Power Controller contains supervisory circuitry that performs:

- battery charge control (battery switch circuits provide a minimum of 30 minutes of system power in the event of AC power failure).
- current, voltage, and temperature monitoring.
- AC sensing.
- fan control.

Two 12-volt batteries, wired in series, provide the back-up power.

The Power Controller communicates with the Display Unit through a RS-422, 9.6 kB channel. It receives the On/Standby signal from the system switch through the Anesthesia Control board.

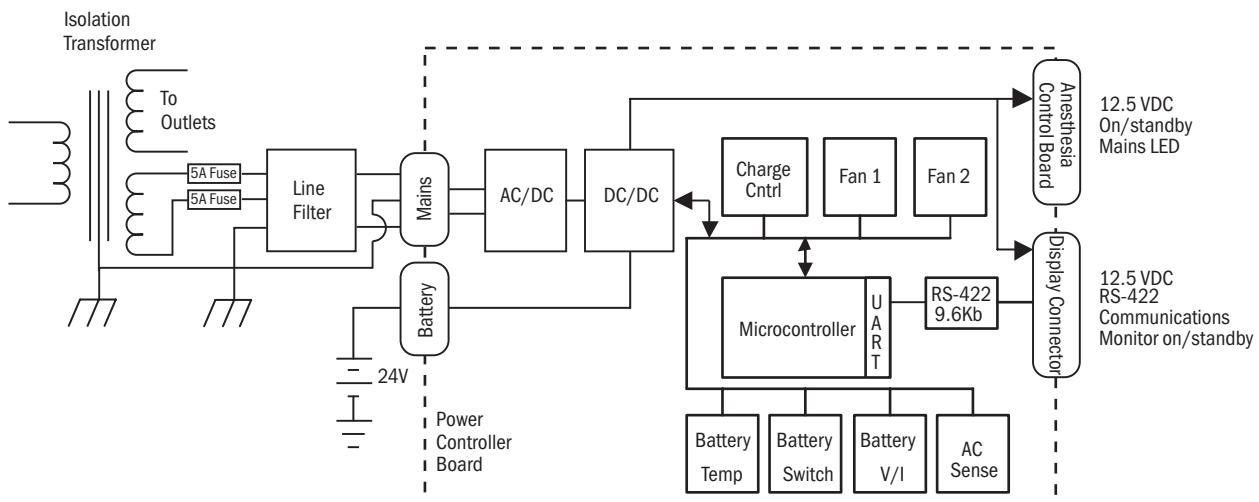


Figure 2-10 • Power subsystem

### **2.2.2 Power distribution**

The Power Controller board provides outputs to the Anesthesia Control board and the Display Connector board. These boards provide local regulation of voltages required by the system.

The Anesthesia Control board interfaces with the Mixer board and the Ventilator Interface board through the Pan Connector board.

The Display Connector board interfaces with the Display Unit and the Module assembly.

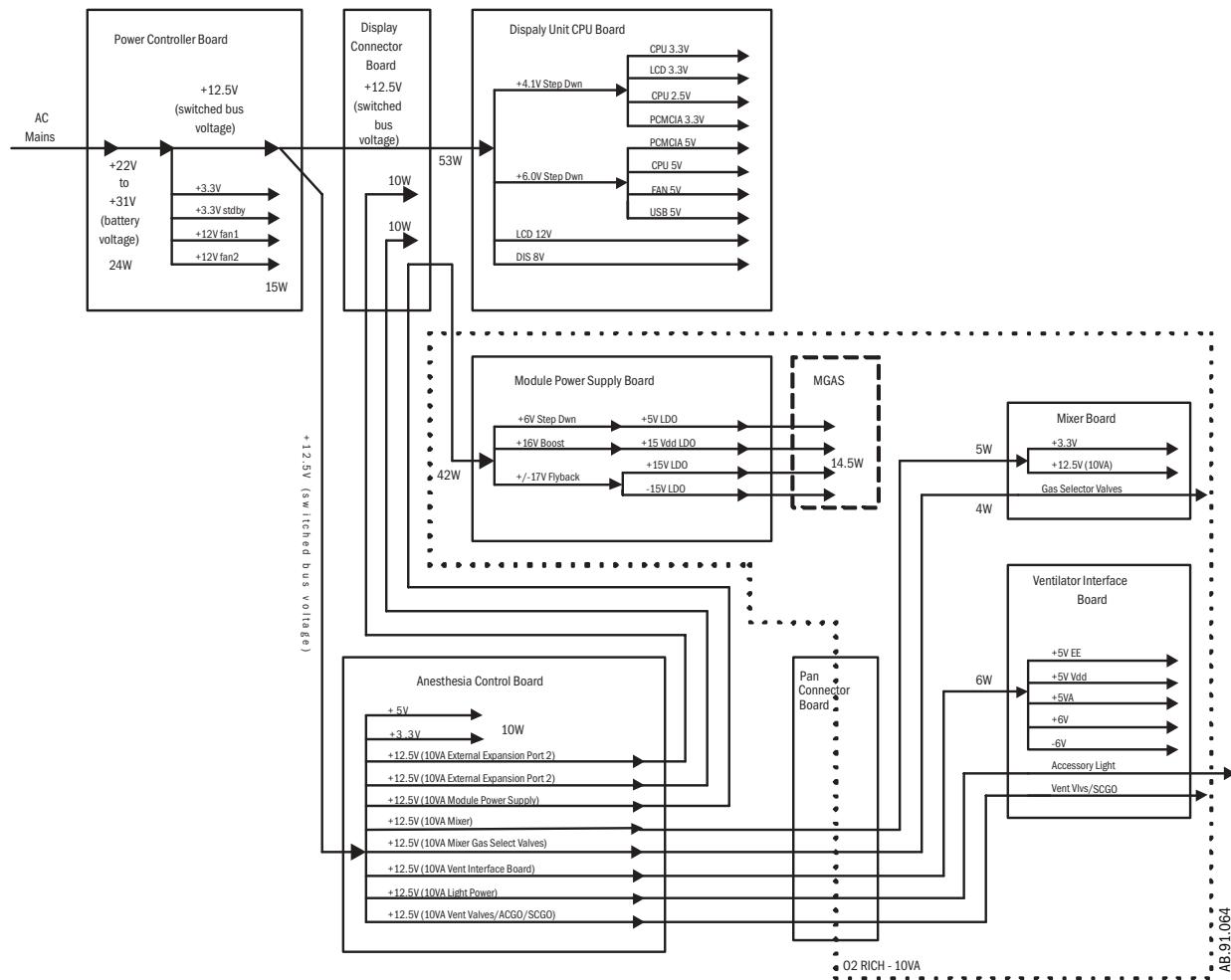


Figure 2-11 • Power distribution

## 2.3 Display Unit

The Display Unit handles most of the machine's user interface functions through the front panel controls and the LCD screen. It is the primary interface to external peripherals.

The main components of the Display Unit include:

- An active matrix thin film transistor liquid crystal display (**A**)
- The CPU board (**B**)
- The System Interconnect assembly (**C**)

The CPU board includes a host processor and three coprocessors to handle display, front panel, and monitoring interfaces.

The Display Unit includes a PCMCIA interface (**D**) to handle software upgrades and to load the diagnostics Service Application.

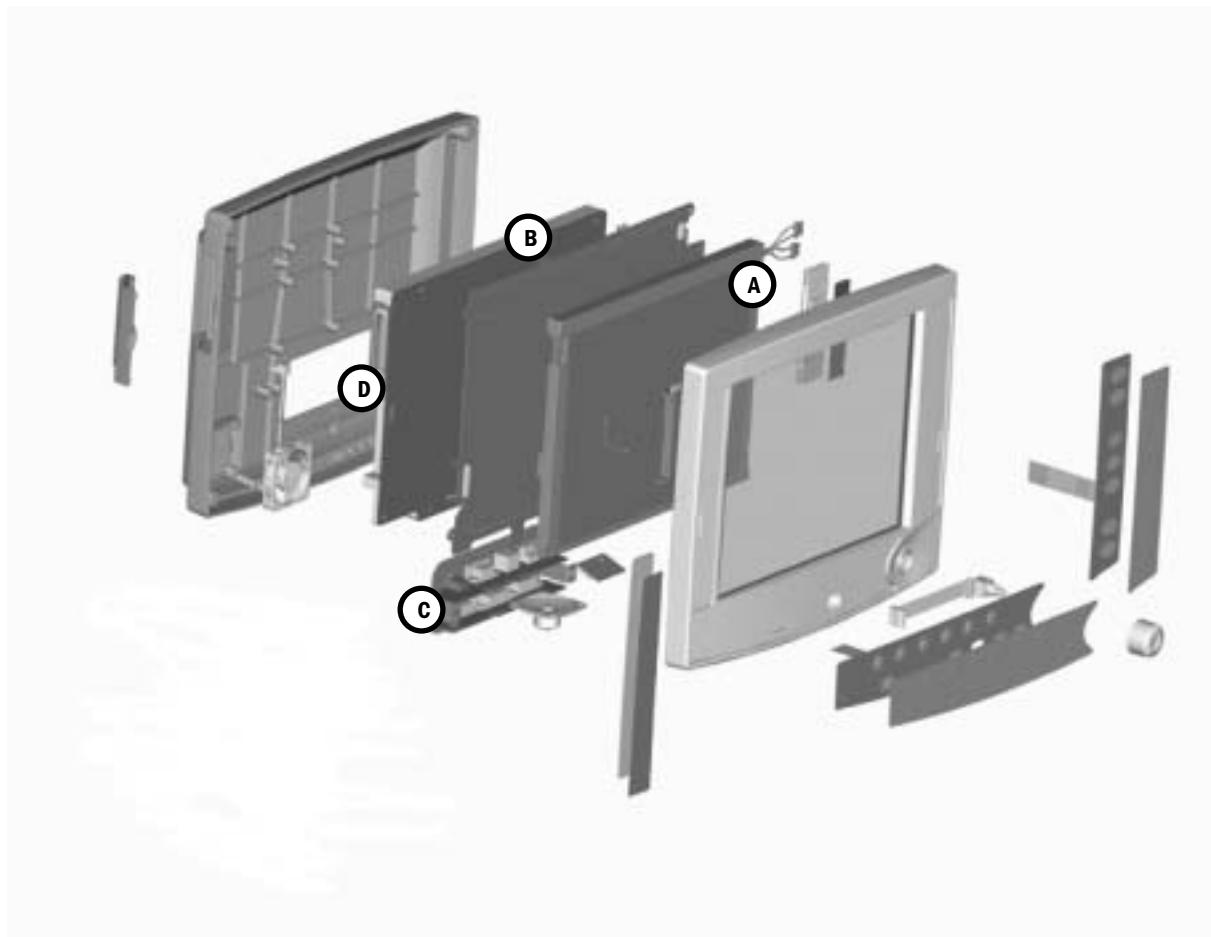


Figure 2-12 • Display Unit

## 2.4 System communications

RS-422 serial communication is used between the two main processors – Display Unit and Anesthesia Computer – and the subsystem processors. Various baud rates accommodate data requirements between subsystem and host. External communication uses the standard RS-232 interface.

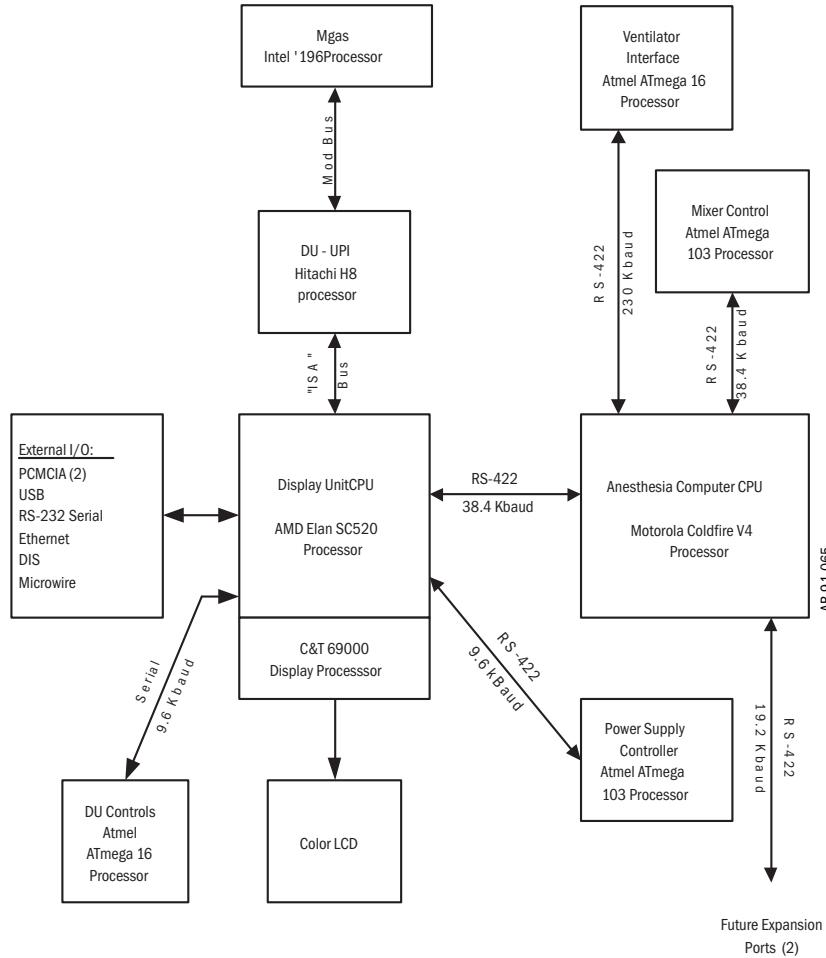


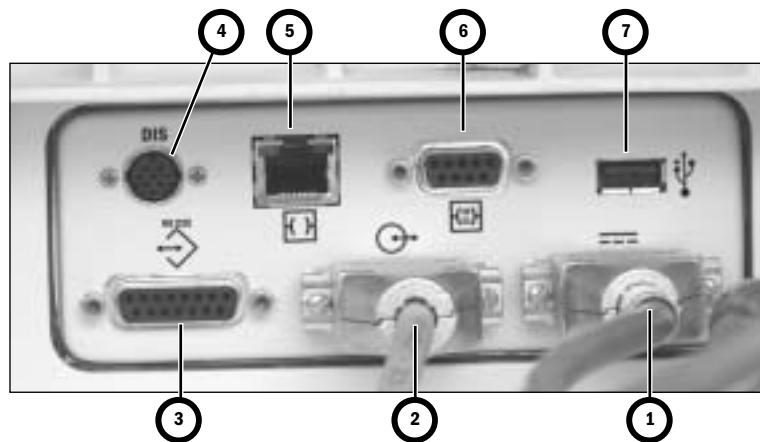
Figure 2-13 • System communications

## 2.5 System connections

### 2.5.1 Display Unit

The Display Unit accommodates the following connections:

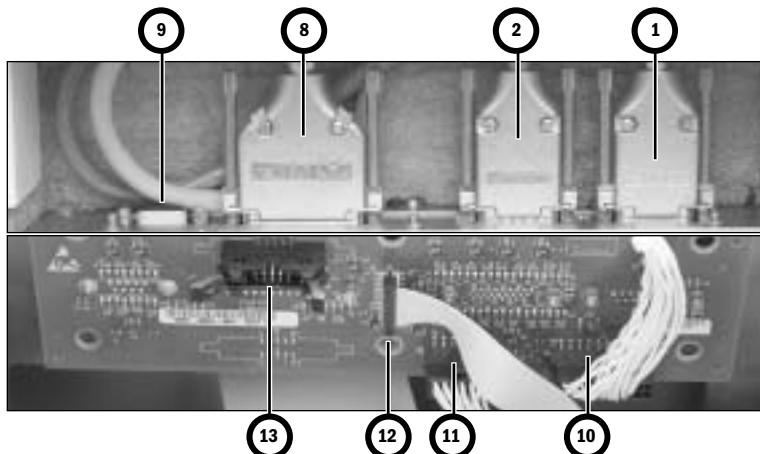
- System Power Interface (1).
- System Signal Interface (2).
- Serial Port – standard interface for external communication (3).
- DIS connector – supports D-O Device Interface Solution (DIS) (4).
- Network connection – Standard Ethernet port for network connectivity (5).
- Network ID – accept D-O proprietary network identification plug (6).
- USB port – standard USB 1.1 interface for external communication with items such as a printer (7).



### 2.5.2 Display Connector board

The top side of the Display Connector board accepts the following cables:

- System Power Interface to Display Unit (1).
- System Signal Interface to Display Unit (2).
- Airway Module (MGAS) Power Supply board (8).
- Not used (9).
- The under side of the Display Connector board accepts the following cables:
  - Power Controller board (10).
  - Anesthesia Control board (MGAS power) connector (11).
  - Anesthesia Control board (signal) connector (12).
  - Not used (13).



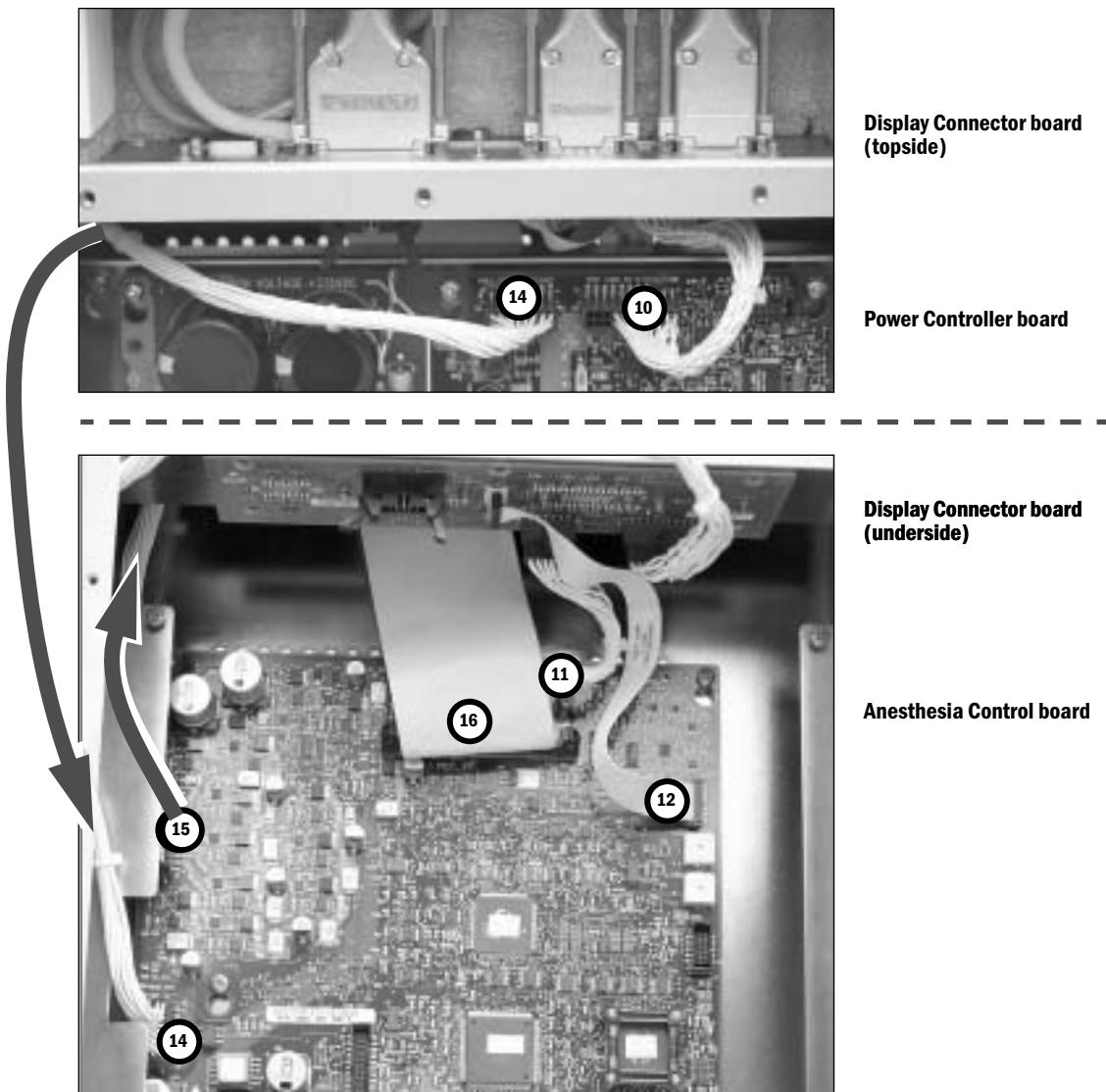
## 2.6 Power Controller and Anesthesia Control board connections

The Power Controller:

- Distributes 12.5 VDC power and communicates with the Display Unit (by way of the Display Connector board) through the connector (**10**).
- Distributes 12.5 VDC power to the Anesthesia Control board through connector (**14**).

The Anesthesia Control board:

- Receives power from the Power Controller board through connector (**14**).
- Distributes 10VA power supplies to the Pan Connector board through connector (**15**).
- Communicates with Pan assemblies through connector (**16**).
- Communicates with Display Unit through connector (**12**).
- Distributes 10VA power supplies to the Display Unit through connector (**11**).



## 2.7 Anesthesia Control board

The Anesthesia Control board (**A**) uses a Motorola MCF5307 Coldfire microcontroller with 4M Flash and 16M error correcting DRAM. The Anesthesia Control board includes 6 UARTs with a 64 byte FIFO and RS-422 communications to interface with the Display Unit, an accessory port, and anesthesia delivery subsystems located in the pan electronic enclosure. These include the Gas Mixer and the Ventilator Interface board.

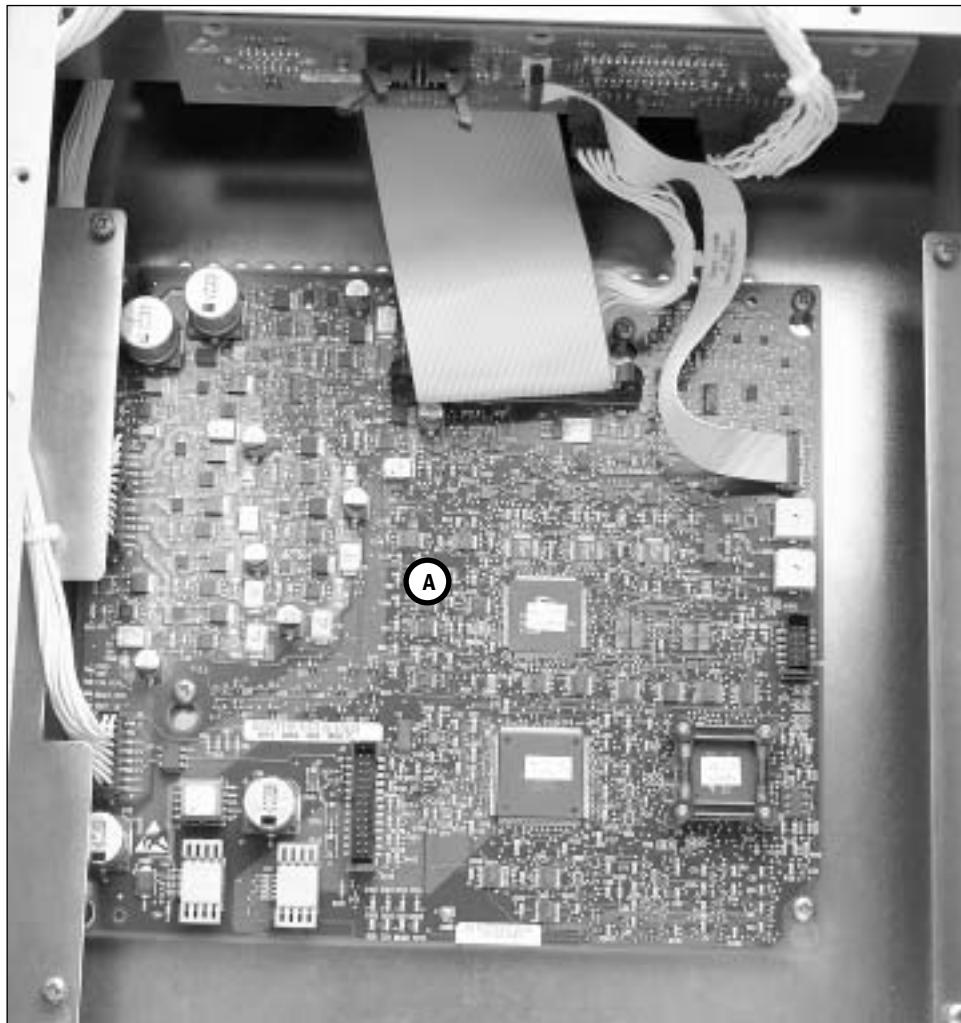


Figure 2-14 • Anesthesia Control board

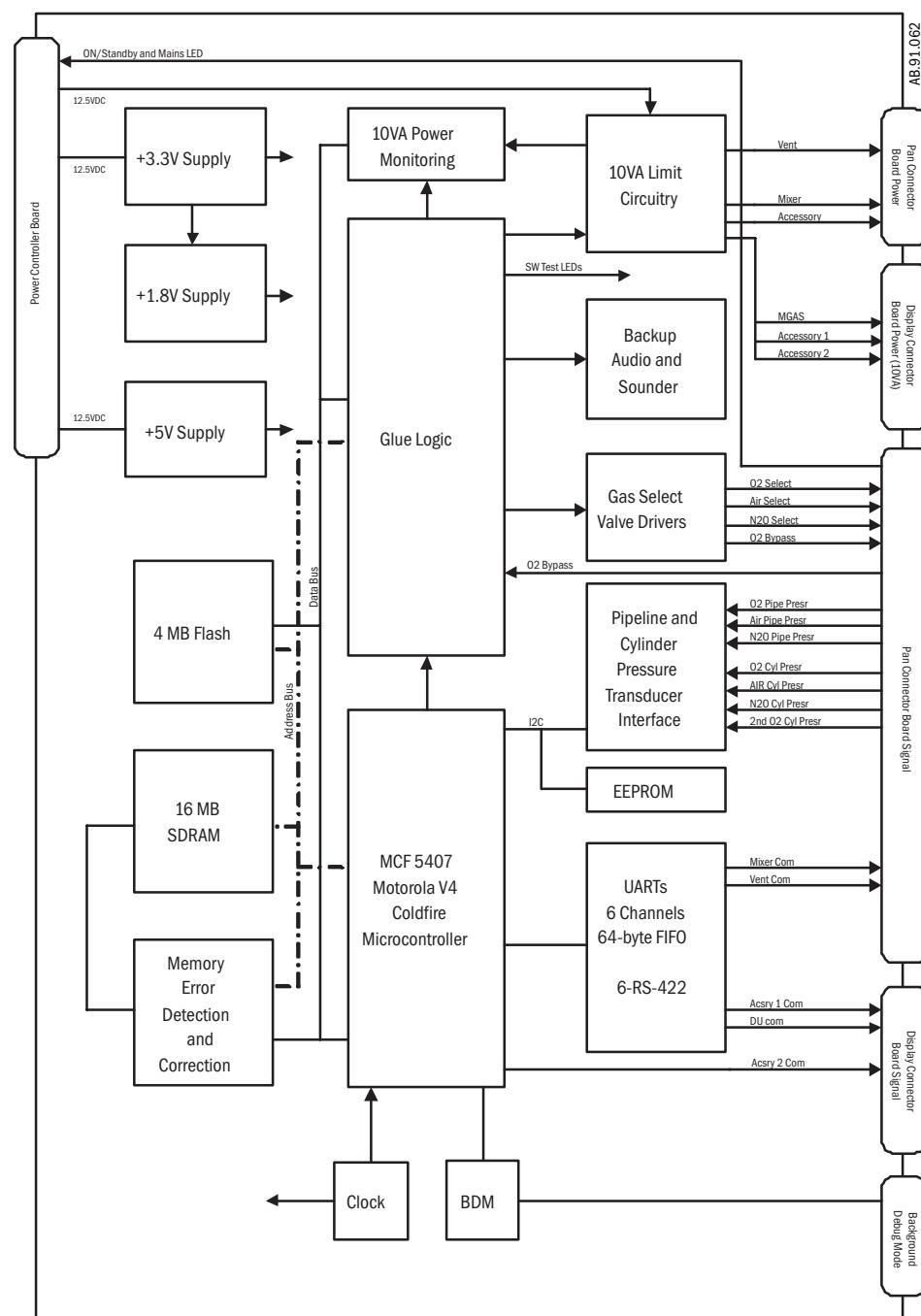


Figure 2-15 • Anesthesia Control board block diagram

## 2.8 Electronic Gas Mixer

The Gas Mixer receives its pneumatic inputs from the pipeline and cylinder supplies and sends mixed gas to the vaporizer manifold. The Gas Mixer interfaces to the Anesthesia Control board for power and communications.

The Gas Mixer consists of the following subassemblies and main components:

- Gas Mixer board (**A**)
- Control Manifold (**B**) – manifold, selector valves, proportional valves
- Flow sensor assembly (**C**)
- Mixed gas manifold and exit check valve (**D**)

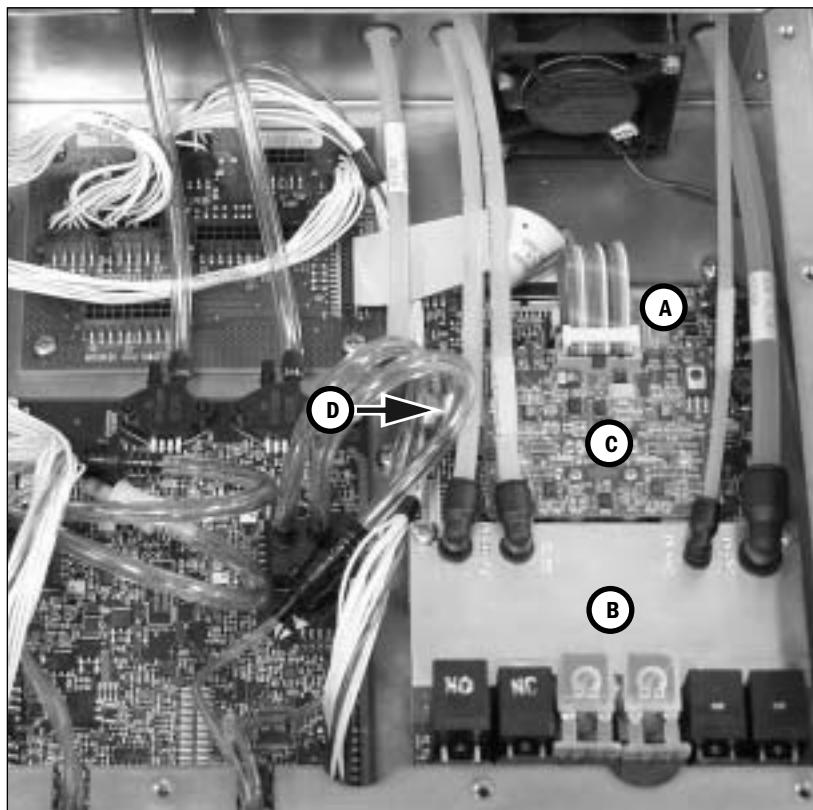


Figure 2-16 • Electronic Gas Mixer

Desired gas flows are sent from the Anesthesia Control board to the Gas Mixer.

Gas Mixer operation is controlled through a microcontroller which:

- Opens and closes selector valves for O<sub>2</sub>, N<sub>2</sub>O and Air.
- Regulates flow control valves for O<sub>2</sub> and balance gas (N<sub>2</sub>O or Air).

Closed-loop flow control is accomplished through a hot-wire anemometer in concert with the flow control valves. Gas flow, based on a calibration table, is on target when the reference measurement equals the flow measurement.

Pressure measurements across each of the flow sensor channels are used as checks on the flow measurement for hazard mitigation, ambient pressure compensation, and compensation for back pressure downstream of the Mixer.

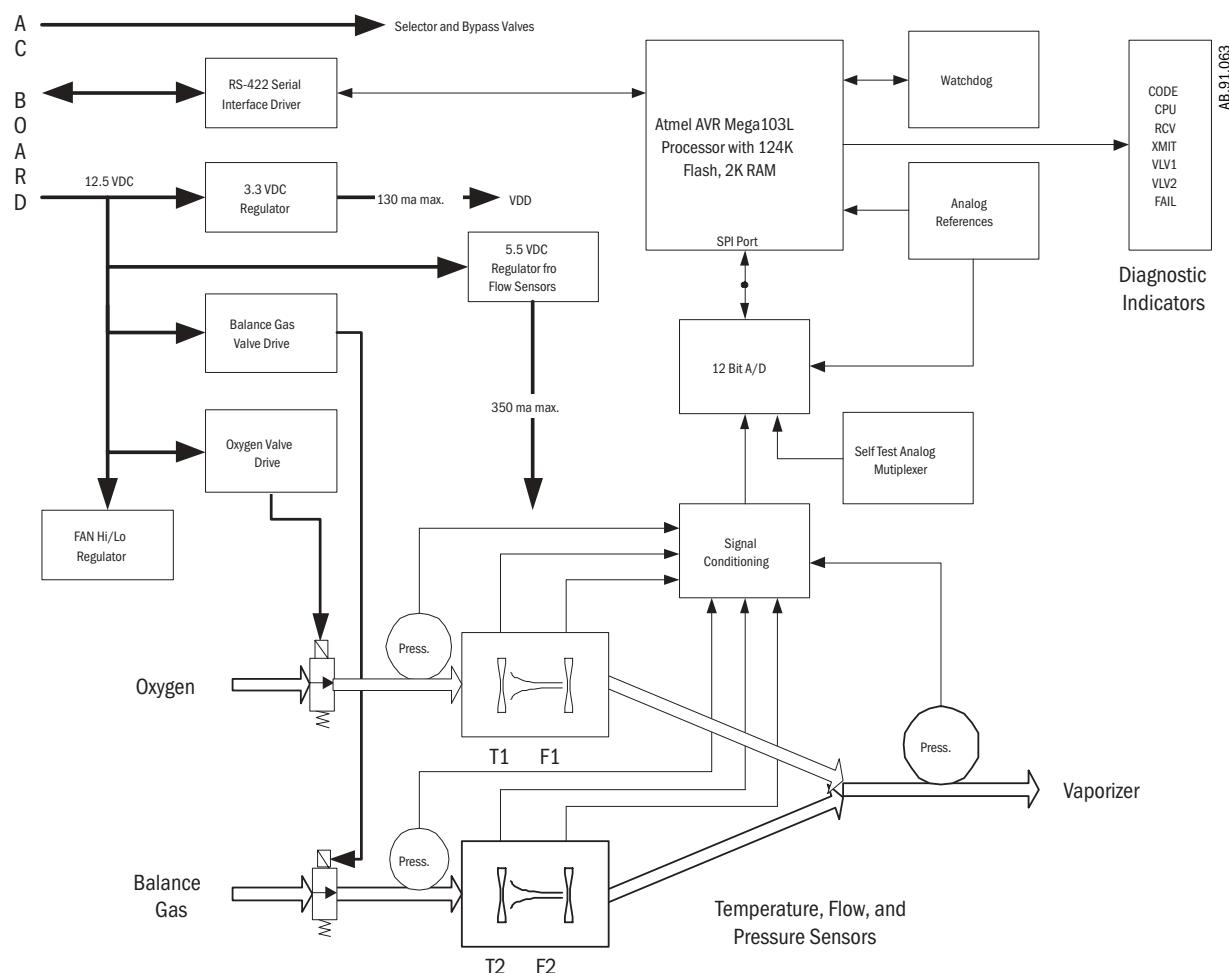


Figure 2-17 • Electronic Gas Mixer block diagram

## 2.9 Ventilator Interface board

The Ventilator Interface board (**A**) provides the electrical and/or pneumatic interface to the following:

- Inspiratory (**B**) and expiratory (**C**) flow sensors (transducers)
- Patient airway (**D**) and manifold (**E**) pressures (transducers)
- Oxygen sensor (in breathing system)
- ABS On switch
- ACGO position switch (if ACGO installed)
- SCGO solenoid, SCGO/CGO position switches (if SCGO installed)
- Bag/Vent switch
- O<sub>2</sub> Flush switch
- Gas Inlet Valve
- Inspiratory Flow Valve
- Accessory Power (for task lights)

The Ventilator Interface board functions are managed locally by a microcontroller. The microcontroller communicates data values to the controlling CPU via an RS-422 serial interface.

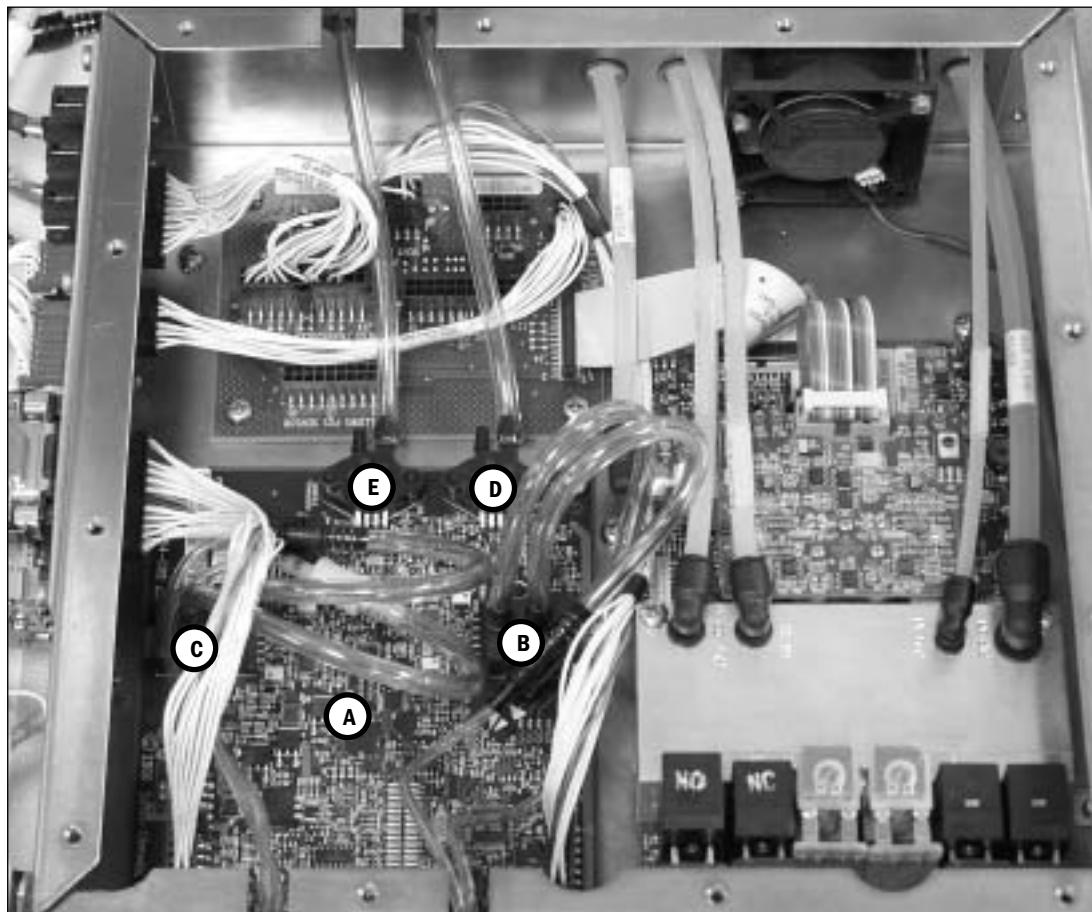


Figure 2-18 • Ventilator Interface board

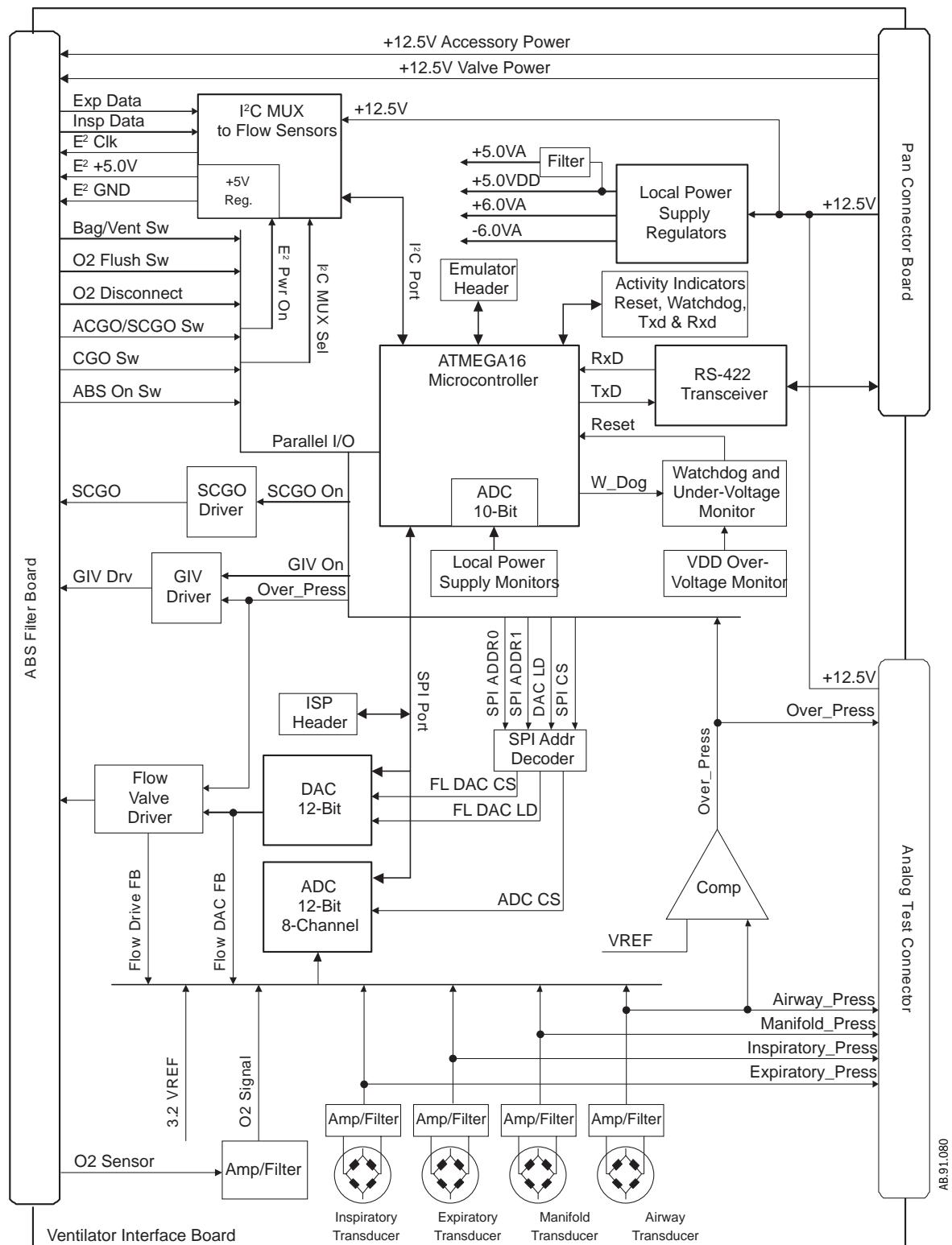


Figure 2-19 • Ventilator Interface board block diagram

## 2.10 Gas flow through the anesthesia machine

### 2.10.1 Overview

Refer to Figure 2-20.

**Gas supplies** Gas comes into the system through a pipeline (1) or cylinder (6) connection. All connections have indexed fittings, filters, and check valves (one-way valves). Pressure transducers monitor the pipeline (2) and cylinder (7) pressures.

The O<sub>2</sub> supply failure alarm is derived from the O<sub>2</sub> pipeline and the O<sub>2</sub> cylinder pressure transducer inputs.

A primary regulator (8) decreases the cylinder pressures to approximately pipeline levels. A pressure relief valve (3) helps protect the system from high pressures.

To help prevent problems with the gas supplies:

- Install yoke plugs on all empty cylinder connections.
- When a pipeline supply is adequate, keep the cylinder valve closed.

**Gas flow** Pipeline or regulated cylinder pressure supplies O<sub>2</sub> or Air directly to the ventilator engine (4a or 4b) and as pilot pressure (4) for the SCGO assembly (E). Connection points are also available for venturi suction (5a or 5b) drive gas supply. An additional O<sub>2</sub> regulator (18) decreases the pressure for the O<sub>2</sub> Flush valve (19) and the auxiliary O<sub>2</sub> flowmeter (24).

The O<sub>2</sub> Flush valve supplies high flows of O<sub>2</sub> to the fresh gas outlet (22 or 23) through the SCGO/ACGO assembly (E/F). The flush pressure switch (20) monitors activation of the flush valve.

**Gas mixing** Under normal conditions, with the system switch (10) in the On position, the Alternate O<sub>2</sub> Disable valve (13) is energized to block alternate O<sub>2</sub> flow. Normal gas flows are enabled through their respective selector valves (11). The system controls gas flow through the flow control valves (12) and derives the individual flow rates through the hot-wire anemometers (14).

Under system failure conditions (or if Alt O<sub>2</sub> is selected), the normally-open Alternate O<sub>2</sub> Disable valve (13) allows delivery of O<sub>2</sub> through the Alternate O<sub>2</sub> Flowmeter when the system switch is in the On position.

**Mixed gas** The mixed gas flows through the vaporizer manifold (D), and vaporizer (16) that is On, to the SCGO/ACGO assembly (E/F). A pressure relief valve (17) on the vaporizer manifold sets the maximum outlet pressure.

The SCGO assembly (E) directs the mixed gas to the selected circuit: 22 (ABS-circle) or 23 (to Inspiratory port of ABS). On SCGO assemblies, a relief valve (21) limits pressure in the breathing system to approximately 150 cmH<sub>2</sub>O.

The ACGO assembly (F) directs the mixed gas to the selected circuit: 22 (ABS-circle) or 23 (external ACGO port).

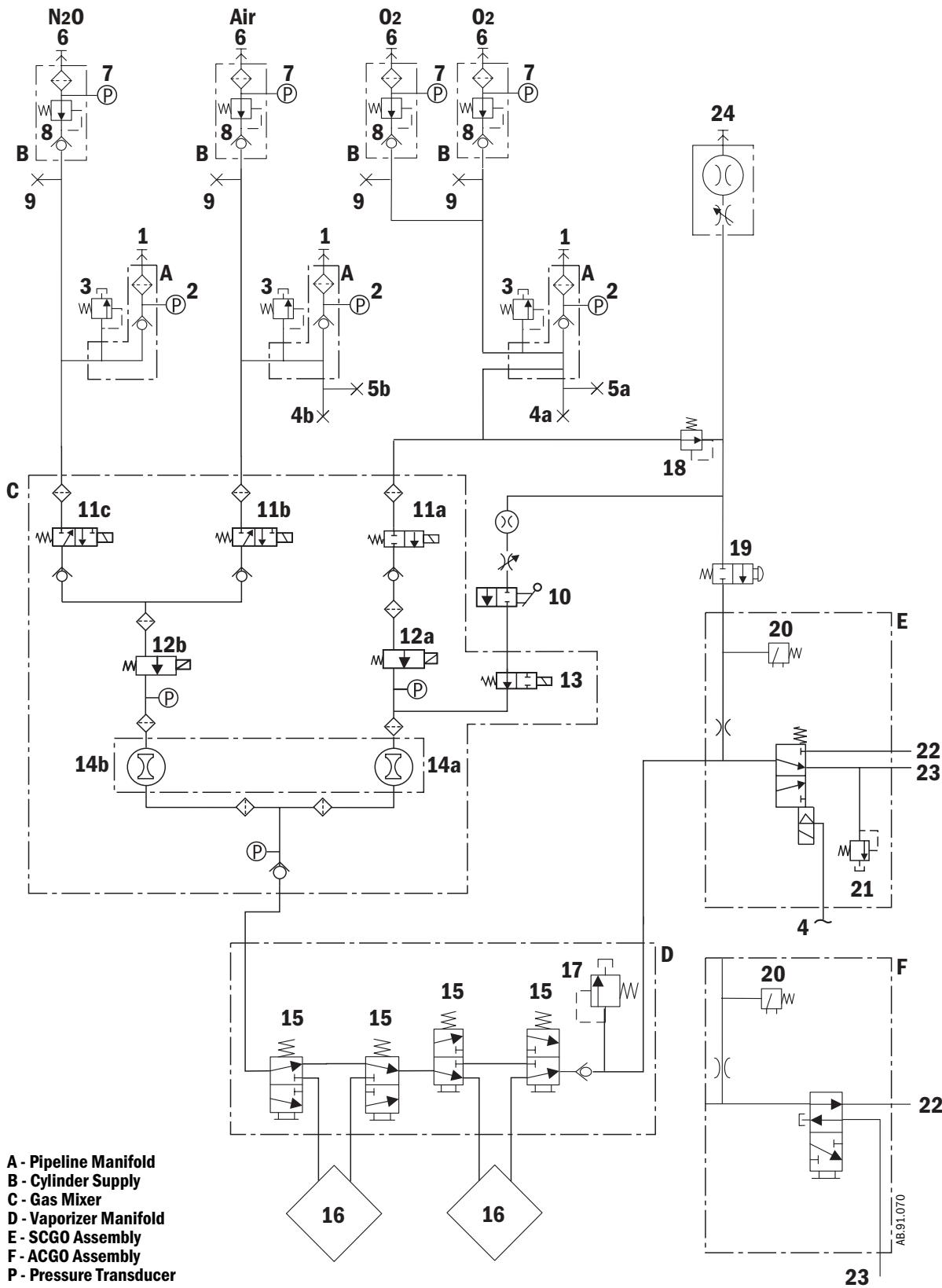


Figure 2-20 • Pneumatic circuit

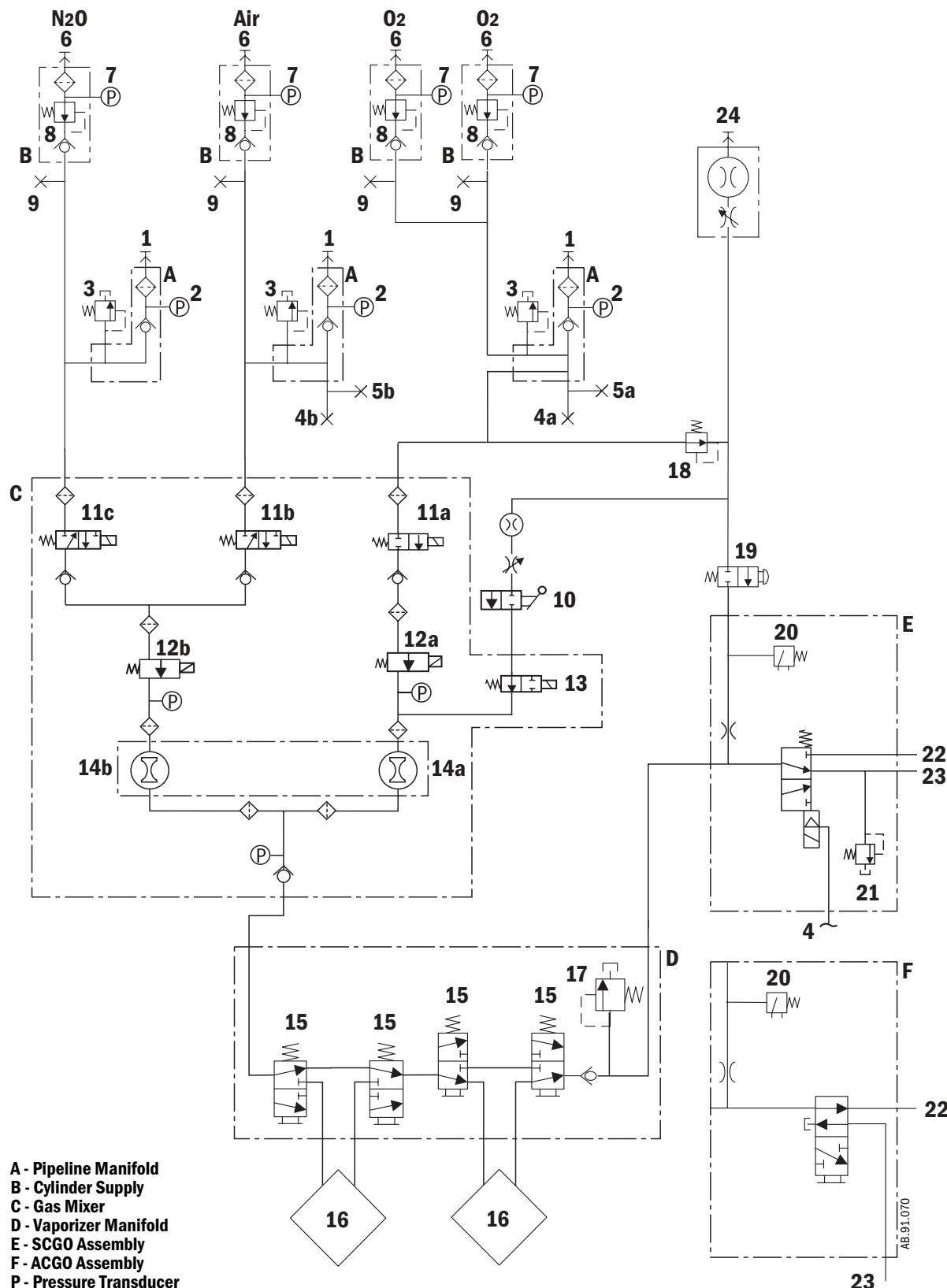


Figure 2-21 • Pneumatic circuit

Refer to Figure 2-21.

**Key to Numbered Components**

1. Pipeline inlet
2. Pipeline pressure transducer
3. High-pressure relief valve (758 kPa / 110 psi)\*
4. Supply connections for the ventilator and pilot pressure for SCGO
  - a. O<sub>2</sub> drive gas
  - b. Air drive gas
5. Venturi suction supply connection
  - a. O<sub>2</sub> drive gas
  - b. Air drive gas
6. Cylinder inlet
7. Cylinder pressure transducer
8. Primary regulator (cylinder pressure)
9. Test port (primary regulator)
10. System switch
11. Selector valve  
a = O<sub>2</sub>; b = Air; c = N<sub>2</sub>O
12. Flow controller  
a = O<sub>2</sub>; b = balance gas
13. Alternate O<sub>2</sub> disable valve
14. Hot-wire anemometer  
a = O<sub>2</sub> flow sensor channel; b = balance gas flow sensor channel
15. Vaporizer port valve
16. Vaporizer
17. Low-pressure relief valve (38 kPa / 5.5 psi)\*
18. O<sub>2</sub> flush and auxiliary flowmeter regulator (241 kPa / 35 psi)\*
19. O<sub>2</sub> Flush valve
20. Pressure switch (used with the ventilator)
21. Breathing system pressure relief valve (SCGO only – 150 cmH<sub>2</sub>O)\*
22. To Port 3 of ABS interface (circle)
23. For SCGO, to Port 2 of ABS interface (non-circle Inspiratory port)  
For ACGO, to external 22-mm ACGO connector
24. Auxiliary O<sub>2</sub> flowmeter (optional)

\* Approximate values

**Key to Symbols**

- |       |                      |
|-------|----------------------|
| ↖ ↗ ↖ | Pneumatic Connection |
| ◊     | Filter               |
| ▷     | Direction of Flow    |
| ◇     | Check Valve          |

## 2.10.2 Physical connections

Figure 2-22 shows the physical path that the gas takes. The item numbers are described on the previous page.

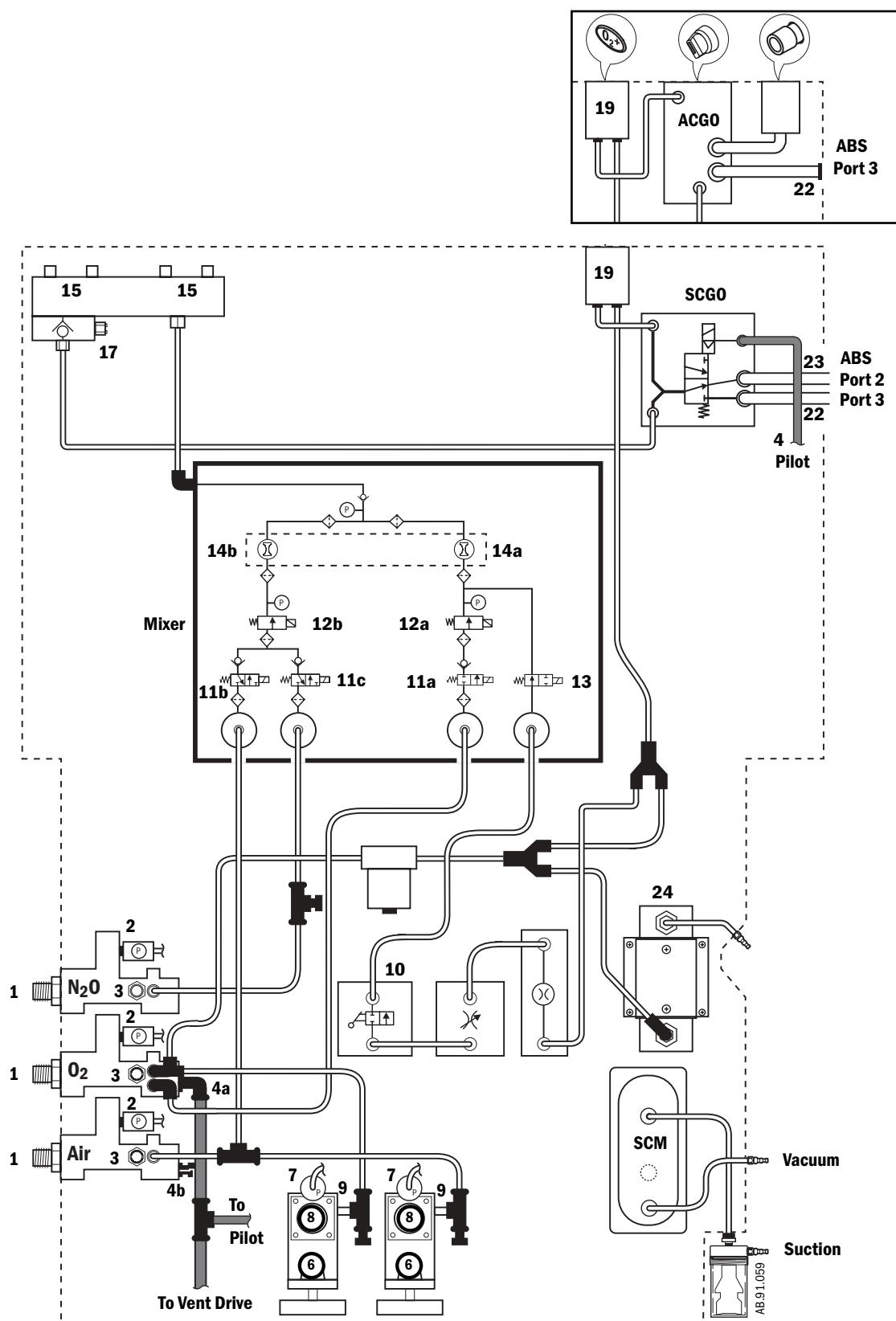


Figure 2-22 • Typical tubing connections - pictorial

### 2.10.3 Suction regulators Pipeline vacuum

The suction regulator (shown in Figure 2-22) uses an external vacuum source.

#### Venturi Drive vacuum

The suction regulator (shown in Figure 2-23) uses an internal, venturi derived vacuum source.

Drive gas (internally plumbed **Air or O<sub>2</sub>**) enters the Venturi Module (**VM**) at the drive port (**A**). As the drive gas passes through the venturi module, a vacuum is created at port **B**. The drive gas exits the venturi module at port **C** and is exhausted outside the machine through the muffler (**D**).

The control port (**E**) on the venturi module responds to pneumatic signals from the front panel switch on the Suction Control Module (**SCM**) to turn the venturi vacuum drive gas on or off. The check valve (**CV**) helps prevent pressurization of the suction circuitry if the exhaust is occluded or the venturi unit fails.

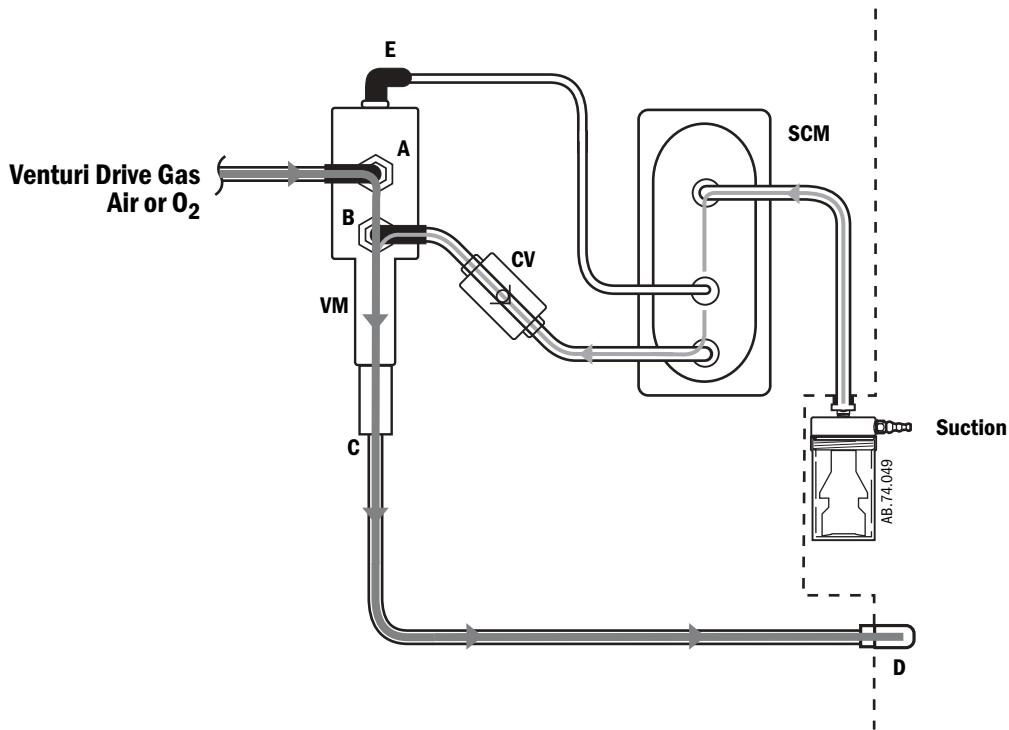


Figure 2-23 • Venturi suction

## 2.11 Flow through the breathing system

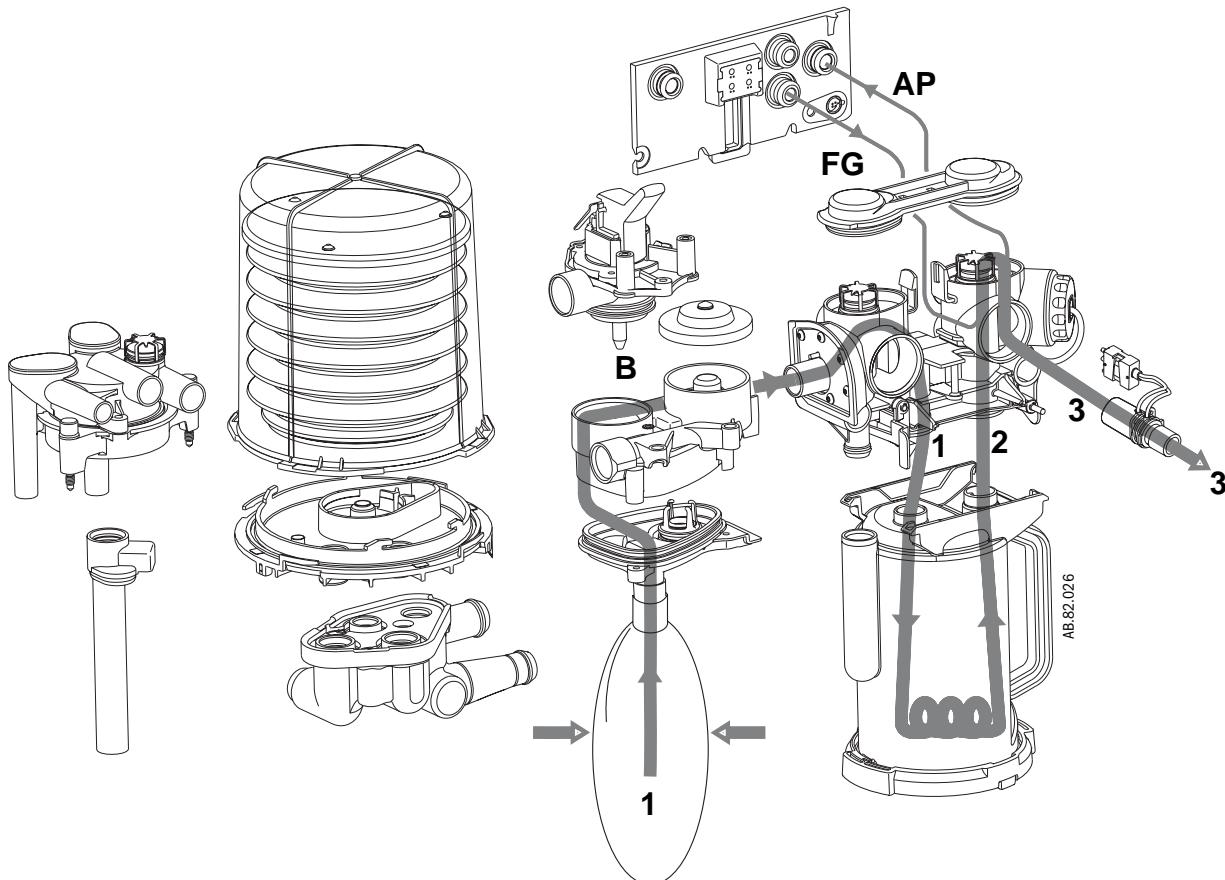
### 2.11.1 Overview of flow paths

This section looks at three types of flow paths.

- **Ventilation paths:** How gas flows from the drive source (bag or bellows) to and from the patient.
- **Fresh gas paths:** Fresh gas can flow from the machine interface directly to the patient through the inspiratory check valve, or through the absorber into the expiratory flow, or directly to an external circuit through the optional auxiliary common gas outlet.
- **Scavenged gas paths:** APL or Pop-off.

## 2.11.2 Manual ventilation

- Manual inspiration** (Figure 2-24) The Bag/Vent switch closes the ventilator path (**B**). Gas flows from the bag (**1**), through the absorber (**2**), into the breathing circuit module, and through a unidirectional valve (inspiratory check valve) to the patient (**3**). During inspiration, fresh gas (**FG**) flows from the machine into the inspiratory limb, upstream of the inspiratory check valve.



- |           |                        |
|-----------|------------------------|
| <b>AP</b> | Airway Pressure        |
| <b>B</b>  | Bag/Vent switch to Bag |
| <b>FG</b> | Fresh Gas              |
| <b>1</b>  | Flow to absorber       |
| <b>2</b>  | Flow from absorber     |
| <b>3</b>  | Inspiratory flow       |

Figure 2-24 • Gas flow during manual inspiration

**Manual expiration**

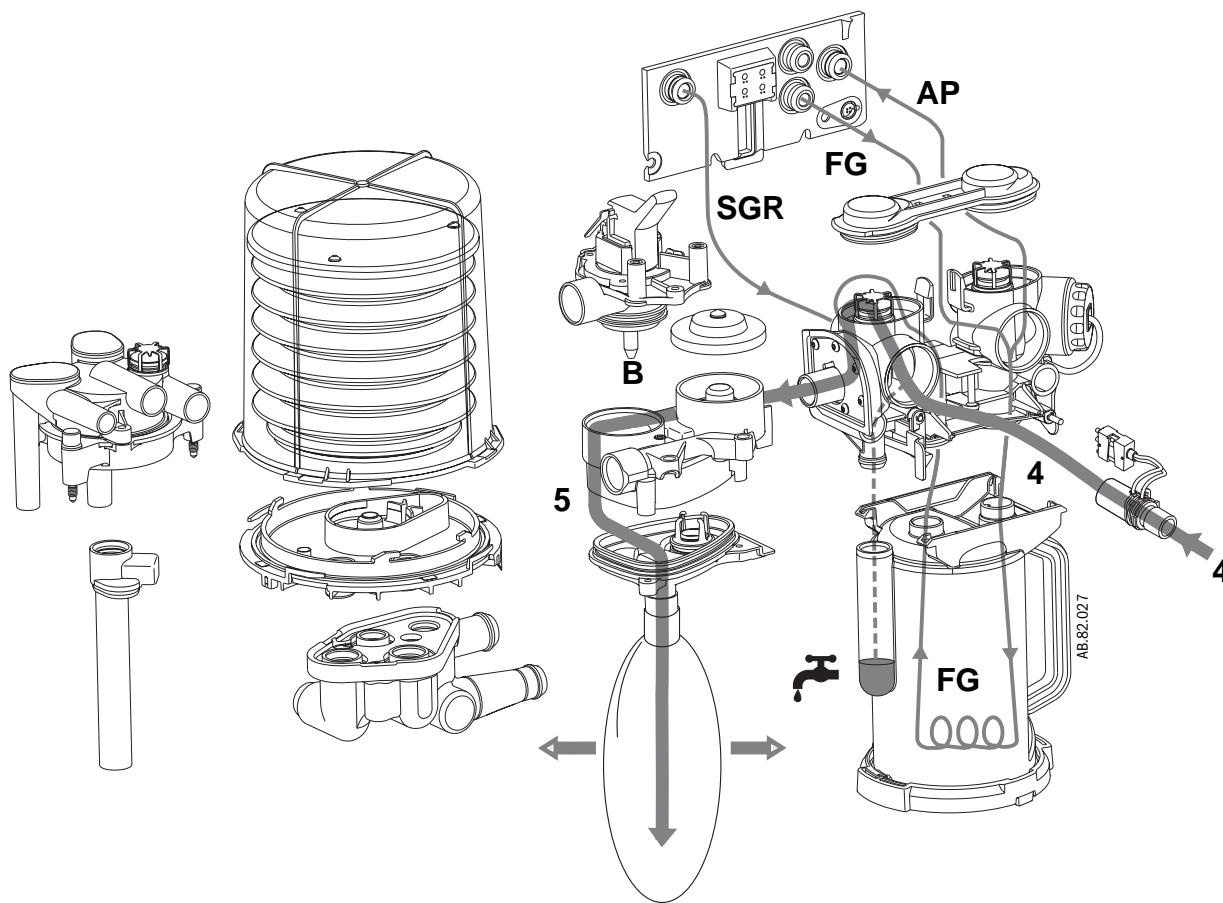
(Figure 2-25)

The Bag/Vent switch keeps the ventilator path closed (**B**).

Gas flows from the patient (**4**), through a unidirectional valve (expiratory check valve), and into the bag (**5**).

During exhalation, fresh gas flows backwards through the absorber (**FG**) into the expiratory limb, downstream of the expiratory check valve.

For machines that are plumbed to return sample gas to the breathing system, the returned gas (**SGR**) enters the breathing system after the expiratory check valve (Refer to section 9.23).



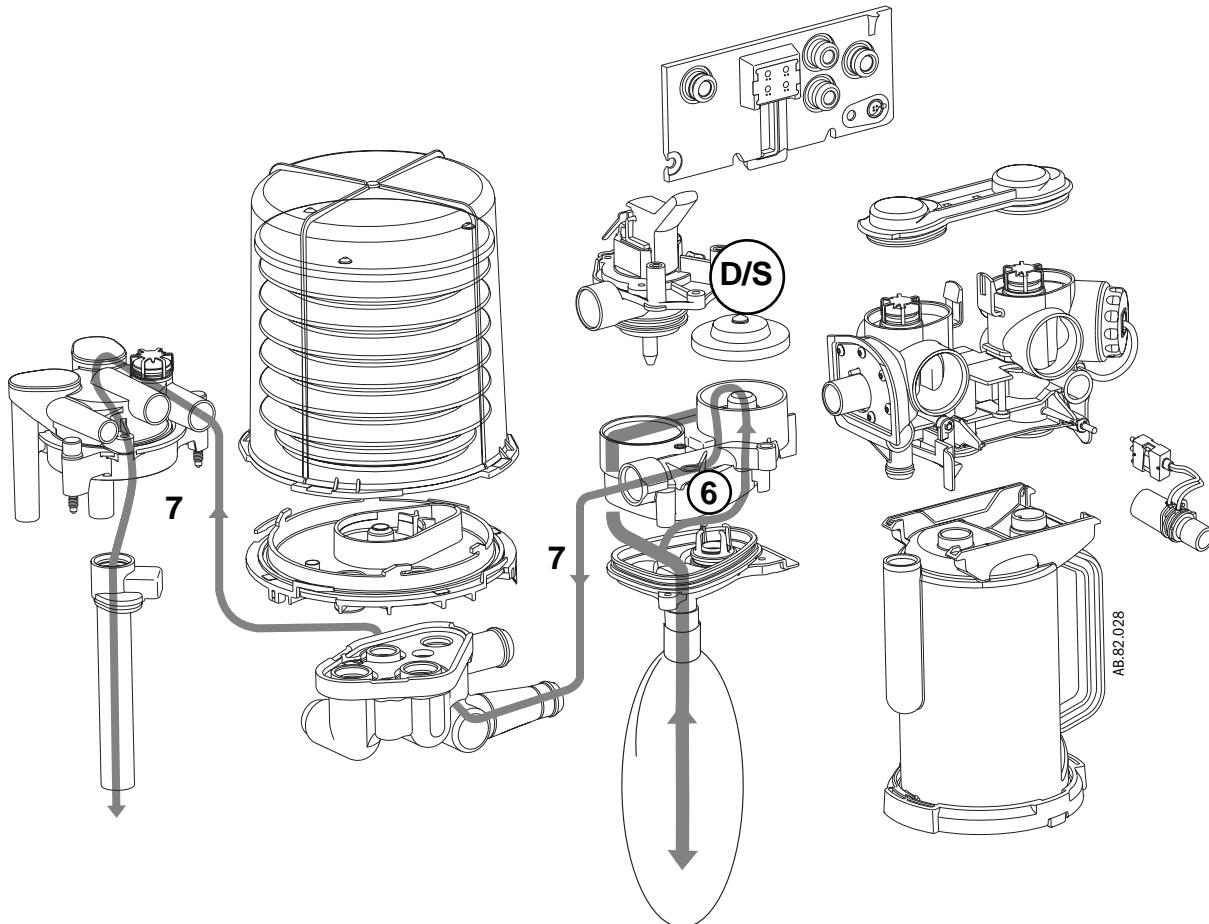
- AP** Airway Pressure
- B** Bag/Vent switch to Bag
- FG** Fresh Gas
- SGR** Sample Gas Return
- 4** Expiratory flow
- 5** Flow to bag

Figure 2-25 • Flow during manual expiration

**APL Valve**  
(Figure 2-26)

The APL valve sets a pressure limit for manual ventilation.

As you turn the APL knob, it puts more or less force on the APL disc and seat (**D/S**). If the circuit pressure is too high (**6**), the disc and seat inside the diaphragm opens and vents gas to the scavenging system (**7**).



- D/S** APL disc and seat
- 6** APL flow
- 7** To scavenging

Figure 2-26 • Flow through the APL Valve

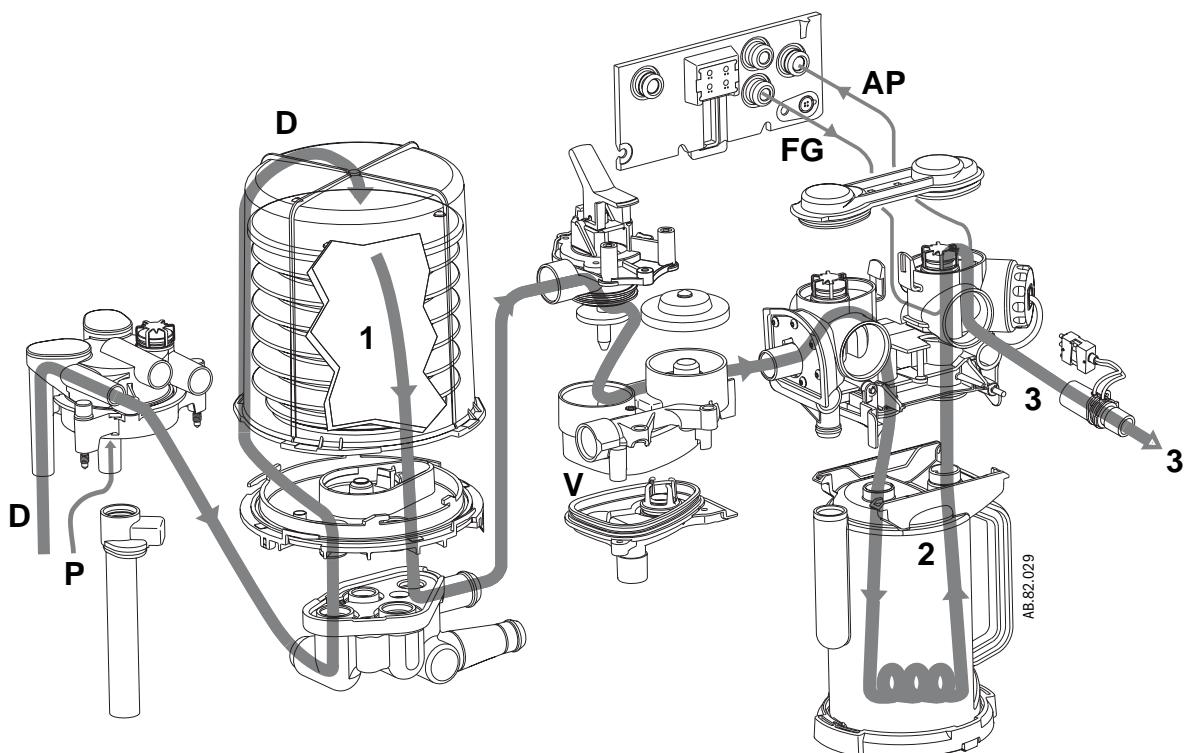
## 2.11.3 Mechanical ventilation

### Mechanical inspiration (Figure 2-27)

The Bag/Vent switch closes the manual path (**V**). Pilot pressure (**P**) closes the exhalation valve.

Drive gas (**D**) pushes down on the bellows. Gas flows from the bellows (**1**), through the absorber (**2**), and through a unidirectional valve (inspiratory check valve) to the patient (**3**).

During inspiration, fresh gas flows into the inspiratory limb, upstream of the inspiratory check valve.



- AP** Airway Pressure
- D** Drive gas
- FG** Fresh Gas
- P** Pilot pressure
- V** Bag/Vent switch to Vent
- 1** Flow to absorber
- 2** Flow from absorber
- 3** Inspiratory flow

Figure 2-27 • Mechanical inspiration

**Mechanical expiration**

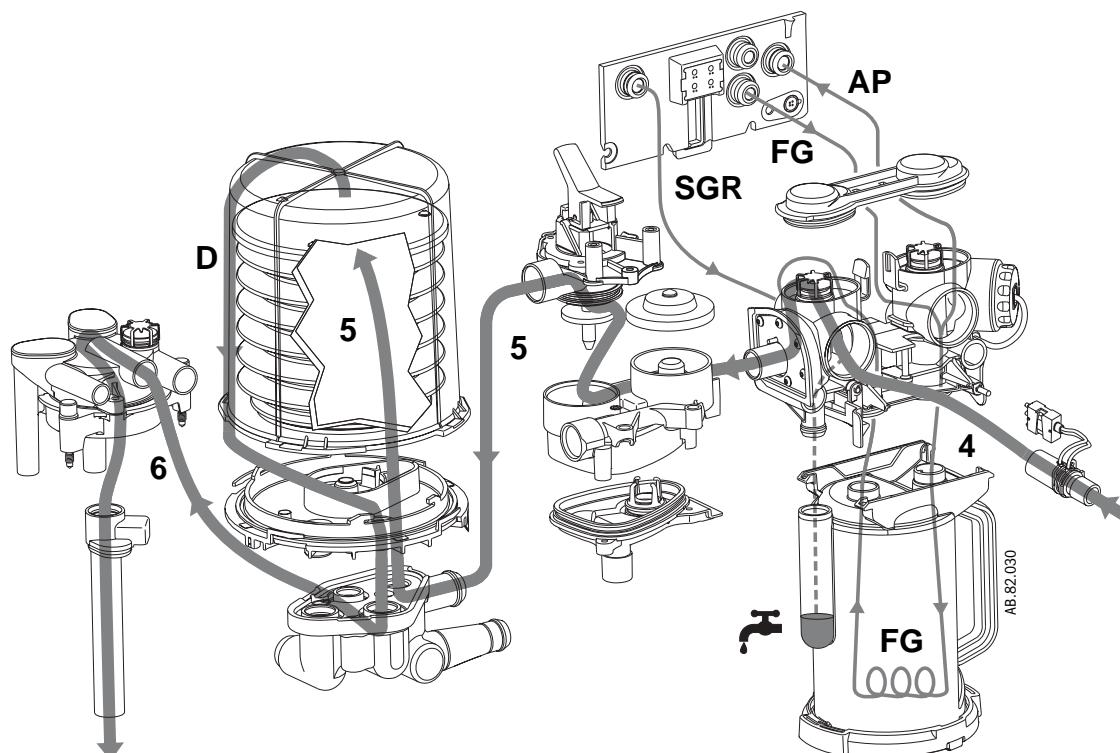
(Figure 2-28)

Drive-gas flow stops and the exhalation valve opens. Exhaled gas flows from the patient (**4**), through a unidirectional valve (expiratory check valve) and into the bellows (**5**). Residual drive gas (**D**) flows out of the bellows to the scavenging system (**6**).

If PEEP is selected, static pressure on the pilot port of the exhalation valve sets the PEEP level.

During exhalation, fresh gas flows backwards through the absorber (**FG**) into the expiratory limb, downstream of the expiratory check valve.

For machines that are plumbed to return sample gas to the breathing system, the returned gas (**SGR**) enters the breathing system after the expiratory check valve (Refer to section 9.23).



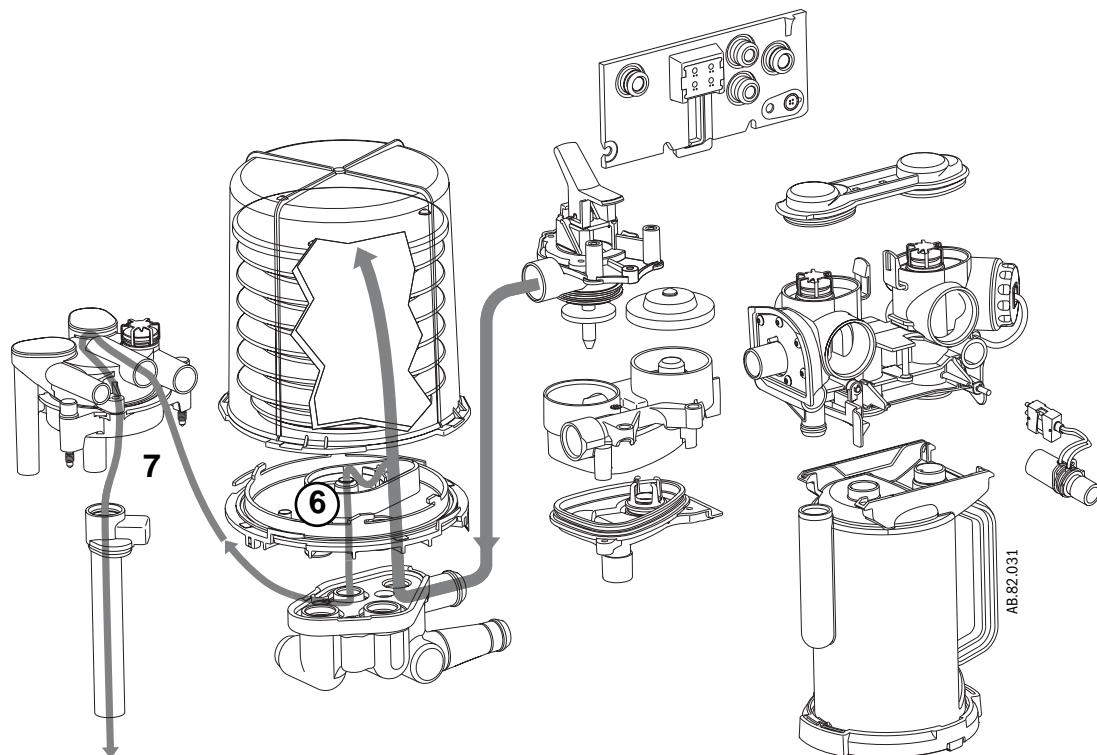
- AP** Airway Pressure
- D** Drive gas
- FG** Fresh Gas
- SGR** Sample Gas Return
- 4** Expiratory flow
- 5** Flow to bellows
- 6** To scavenging

Figure 2-28 • Flow through the APL Valve

**Pop-off valve**  
(Figure 2-29)

The pop-off valve limits the pressure inside the bellows to 2.5 cm H<sub>2</sub>O above the drive gas pressure. This normally occurs when the bellows reaches the top of the housing at the end of exhalation.

Excess gas (7) vents to the scavenging system (6) through the pop-off valve and the exhalation valve.



**6** Pop-off flow

**7** To scavenging

Figure 2-29 • Flow through the pop-off valve

## 2.11.4 Fresh gas and O<sub>2</sub> flush flow (with SCGO)

- To ABS (Circle) breathing system  
(Figure 2-30)**
- Fresh gas (1) flows from the vaporizer manifold outlet to the SCGO assembly. With the Circle system selected, fresh gas flow is channeled to Port 3 of the breathing system (before the inspiratory check valve). The output of the O<sub>2</sub> Flush regulator (2) is channeled to the O<sub>2</sub> Flush valve. When activate, O<sub>2</sub> flush flow joins the fresh gas flow in the SCGO assembly.

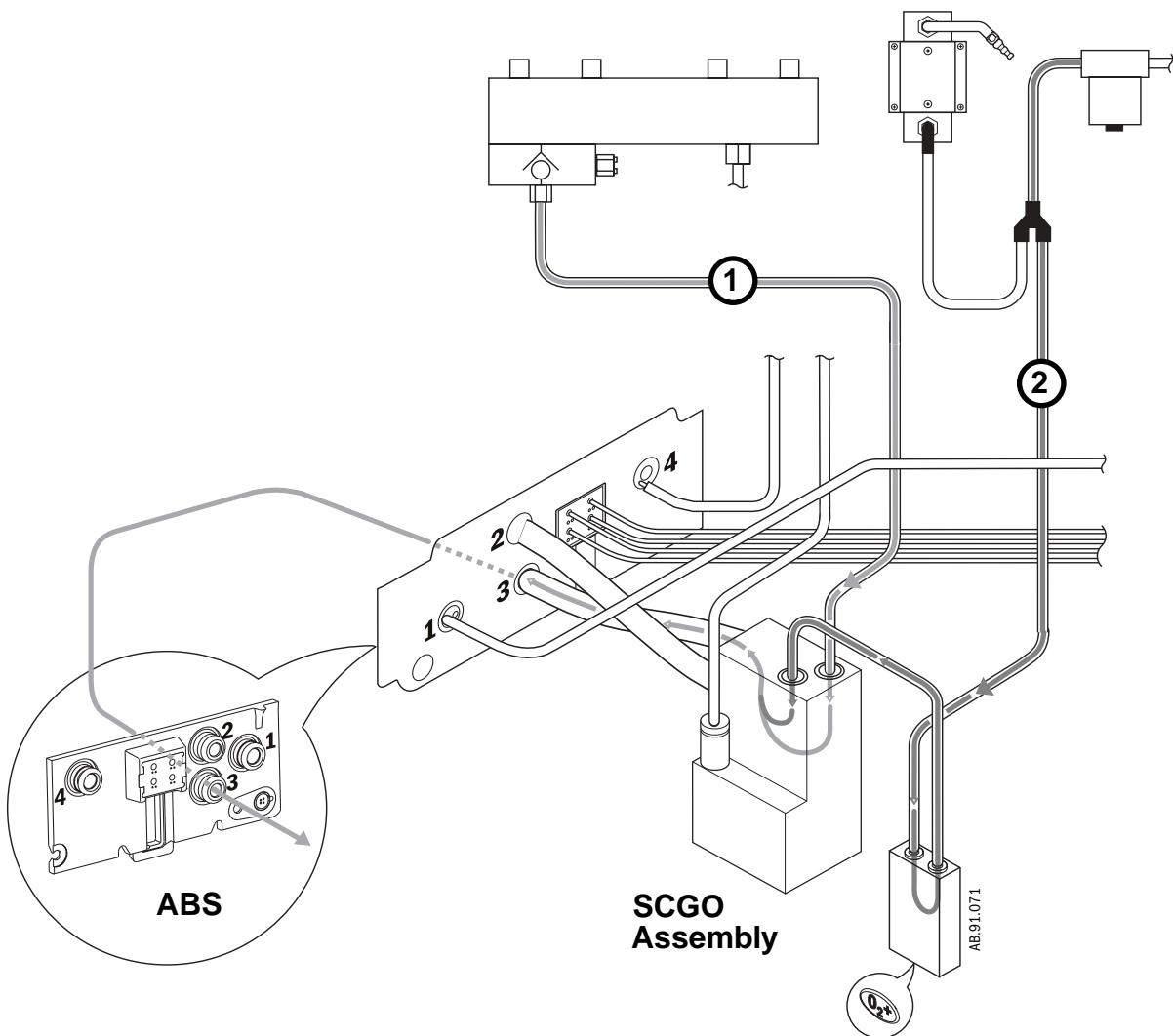


Figure 2-30 • Fresh gas and O<sub>2</sub> flush flow (to ABS)

**Switched (Non-circle)**

**Common Gas Outlet**

(Figure 2-31)

Fresh gas (1) flows from the vaporizer manifold outlet to the SCGO assembly.

With the Non-Circle system selected, fresh gas flow is channeled to Port 2 of the breathing system (after the inspiratory check valve - to an external patient circuit through the Inspiratory port).

The output of the O<sub>2</sub> Flush regulator (2) is channeled to the O<sub>2</sub> Flush valve. When activated, O<sub>2</sub> flush flow joins the fresh gas flow in the SCGO assembly.

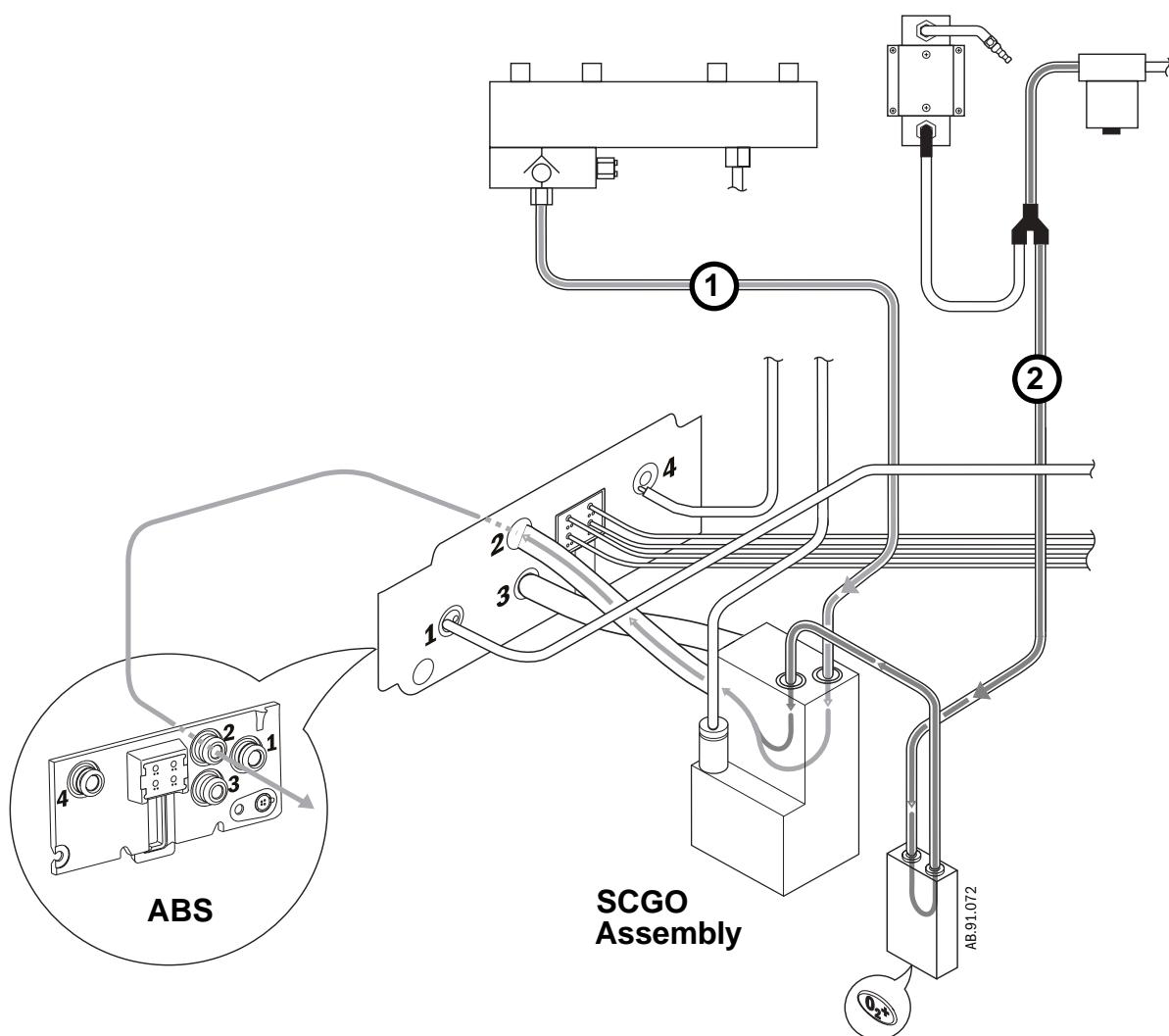


Figure 2-31 • Fresh gas and O<sub>2</sub> flush flow (to ACGO)

## 2.11.5 Fresh gas and O<sub>2</sub> flush flow (with ACGO)

**To ABS (Circle) breathing system  
(Figure 2-32)**

Fresh gas (1) flows from the vaporizer manifold outlet to the ACGO Selector Switch.

With the ACGO Selector Switch in the ABS position, fresh gas flow is channeled to the breathing system.

The output of the O<sub>2</sub> Flush regulator (2) is channeled to the O<sub>2</sub> Flush valve.

When activate, O<sub>2</sub> flush flow joins the fresh gas flow in the ACGO Selector Switch.

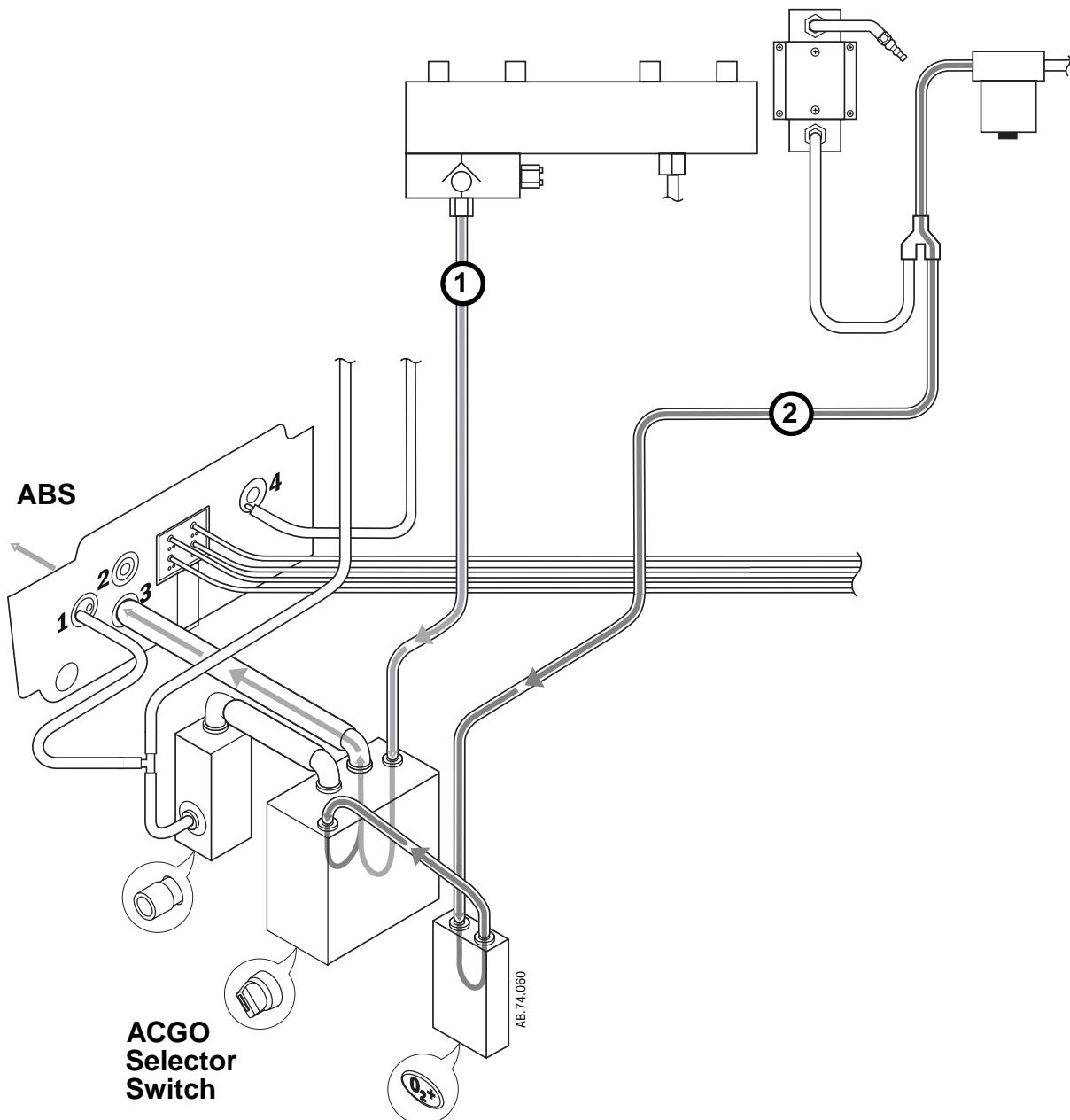


Figure 2-32 • Fresh gas and O<sub>2</sub> flush flow (to ABS)

**Auxiliary (Non-circle)**

**Common Gas Outlet**

(Figure 2-33)

Fresh gas (1) flows from the vaporizer manifold outlet to the ACGO Selector Switch.

With the ACGO Selector Switch in the ACGO position, fresh gas flow is channeled to the ACGO outlet.

At the ACGO outlet, a small sample is diverted to the O<sub>2</sub> Cell in the ABS for O<sub>2</sub> monitoring.

The output of the O<sub>2</sub> Flush regulator (2) is channeled to the O<sub>2</sub> Flush valve.

When activated, O<sub>2</sub> flush flow joins the fresh gas flow in the ACGO Selector Switch.

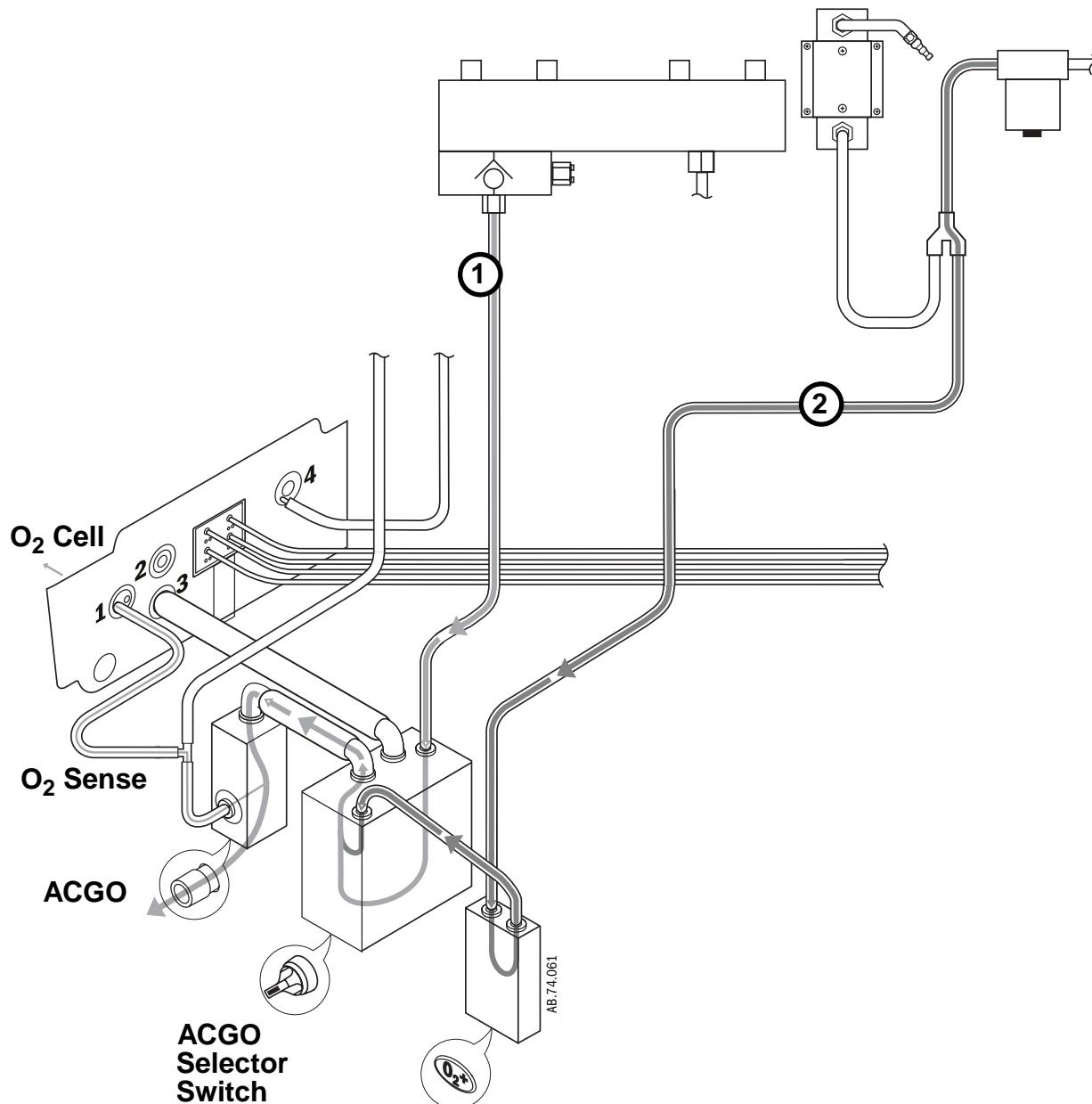


Figure 2-33 • Fresh gas and O<sub>2</sub> flush flow (to ACGO)

## 2.12 Ventilator mechanical subsystems

Refer to Figure 11-1, "System circuit diagram" in Section 11, for the complete pneumatic/mechanical subsystem diagram.

The mechanical subsystems for the ventilator include:

Pneumatic Vent Engine

- Drive gas inlet filter
- Gas inlet valve
- Supply gas pressure regulator
- Flow control valve
- Drive gas check valve
- Mechanical Overpressure Valve (MOPV)
- Bleed resistor
- Free breathing valve

Exhalation valve

Bellows assembly

Breathing circuit flow sensors

### 2.12.1 Drive gas filter and Gas Inlet Valve

Drive gas (can be selected from O<sub>2</sub> or Air) enters the Vent Engine (1) at a pressure of 241 to 690 kPa (35 to 100 psi) through a 2-micron filter (2) that is located under the Gas Inlet Valve (3).

During normal operation the Gas Inlet Valve (GIV) is open to let supply gas flow. The GIV provides a shutoff of the supply gas when the ventilator is not in use. The GIV also shuts off supply gas to the ventilator under failure conditions detected by the CPU or over-pressure switch. The output from the GIV stays at the filtered supply gas pressure.

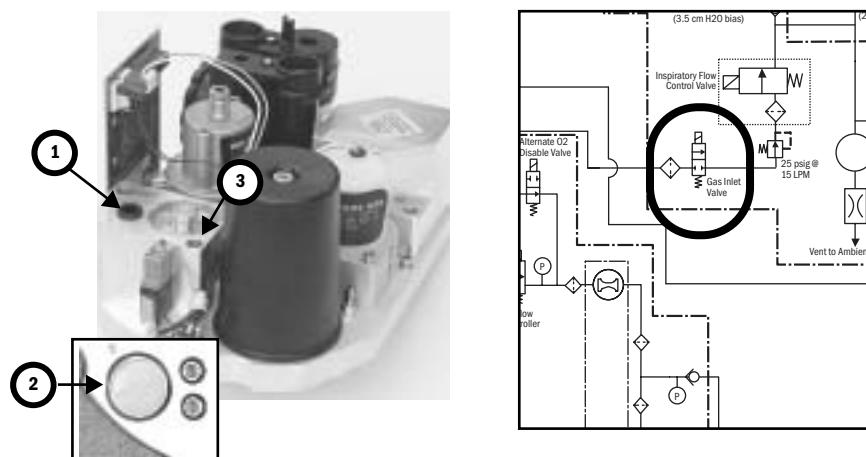


Figure 2-34 • Inlet filter and Gas Inlet Valve (GIV)

## 2.12.2 Pressure regulator

The pressure regulator (4) is a non-relieving pressure regulator that regulates high pressure filtered supply gas down to 172 kPa (25 psi).

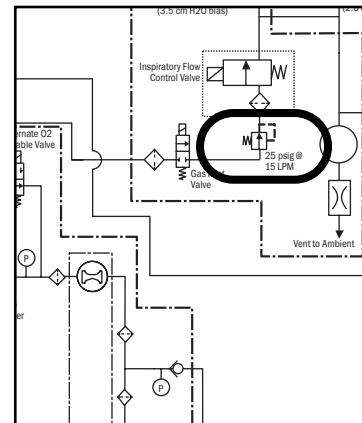


Figure 2-35 • Pressure regulator

## 2.12.3 Flow control valve

The flow control valve (5) is controlled by the CPU. Signals are sent to the flow control valve of the necessary flow determined by ventilator settings and sensor signals. The flow control valve modulates the incoming 172 kPa (25 psi) drive gases to an output from 0 to 120 liters per minute at pressures ranging from 0 to 100 cm H<sub>2</sub>O.

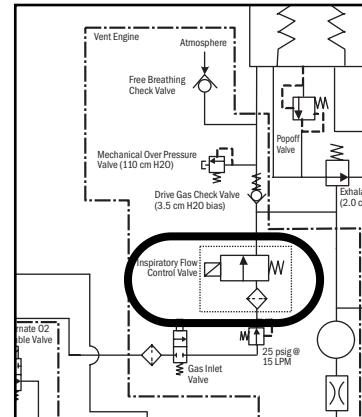


Figure 2-36 • Flow control valve

## 2.12.4 Drive Gas Check Valve (DGCV)

The Drive Gas Check Valve (6) is used downstream of the flow control valve to create the pilot pressure for closing the exhalation valve during inspiratory phases. The DGCV valve is biased shut by an integral weight that supplies approximately 3.5 cm H<sub>2</sub>O of bias pressure before permitting flow downstream to the breathing circuit. When the ventilator is exhausting flow from the breathing circuit, the DGCV permits the exhalation valve pilot pressure to be de-coupled from the circuit pressure. This permits the exhalation valve to open and lets gas flow to the exhaust and the gas scavenging system.

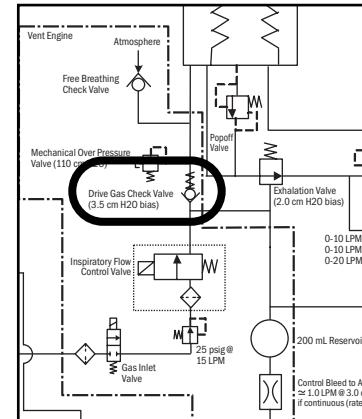


Figure 2-37 • Drive Gas Check Valve

## 2.12.5 Bellows Pressure Relief Valve

The Bellows assembly is the interface between drive gas and patient gas in the breathing system. The pressure relief valve (or pop-off valve) in the bellows assembly (7) controls the pressure in the breathing circuit and exhausts excess patient gas through the exhalation valve.

The pressure relief valve is normally closed, maintaining approximately 1.5 cm H<sub>2</sub>O in the breathing circuit in a no-flow condition, enough to keep the bellows inflated. It is piloted closed during inspiration and remains closed until the bellows is refilled during exhalation. It will exhaust  $\leq 4$  L/min excess fresh gas flow at  $\leq 4$  cm H<sub>2</sub>O.

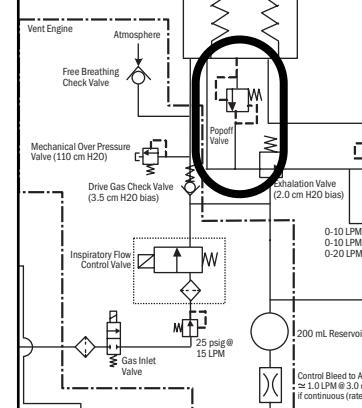


Figure 2-38 • Bellows pressure relief valve

## 2.12.6 Exhalation valve

The exhalation valve contains an elastomeric diaphragm that is used along with the flow valve to control the pressures in the breathing circuit. The exhalation valve includes two male ports on the bottom for:

- Bellows drive gas (8)
- Exhalation valve pilot (9) - (manifold pressure)

The exhalation valve includes three ports on top that connect to the bellows base manifold:

- Drive gas pass through (10)
- Drive gas return and pop-off valve flow (11)
- APL exhaust flow to scavenging (12)

A port at the back of the exhalation valve (13) connects to the down tube that directs all the exhaust flows to the scavenging receiver.

The exhalation valve is normally open. Approximately 2 cm H<sub>2</sub>O of pilot pressure is necessary to close the valve. When the exhalation port is open, gas flows from the bellows housing to the scavenging port.

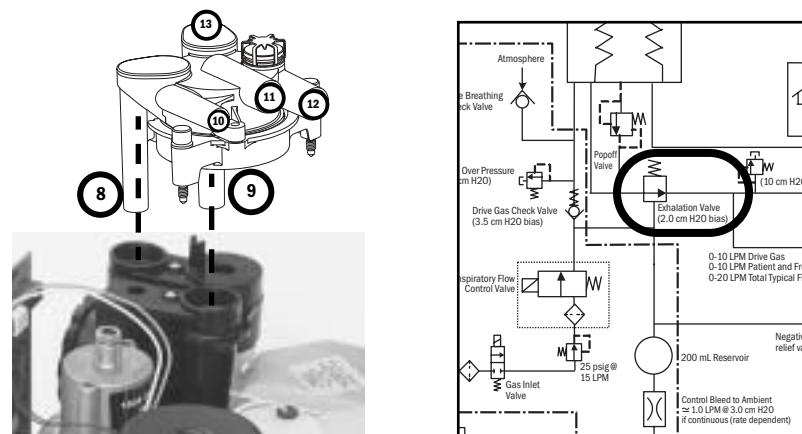


Figure 2-39 • Exhalation valve

## 2.12.7 Mechanical Overpressure Valve

The Mechanical Overpressure Valve (MOPV) is a mechanical valve (**14**) that operates regardless of electrical power. It functions as a third level of redundancy to the ventilator's pressure limit control functions, supplying pressure relief at approximately 110 cm H<sub>2</sub>O.

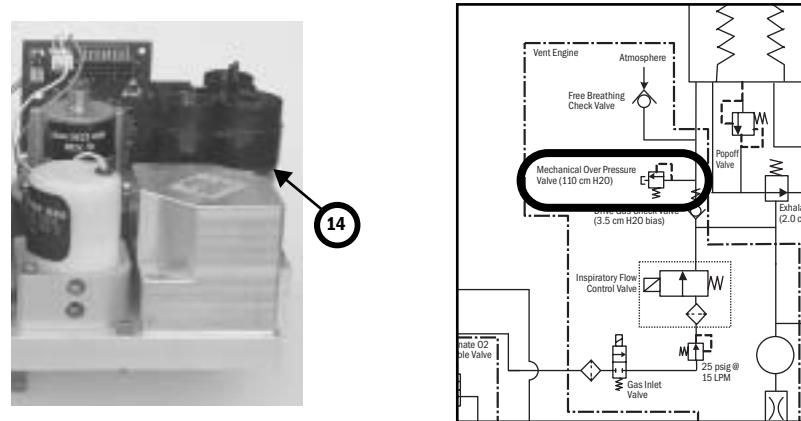


Figure 2-40 • Mechanical overpressure valve

## 2.12.8 Reservoir and bleed resistor

The reservoir (**15**) is a 200 ml chamber that dampens the manifold (pilot) pressure pulses to the exhalation valve.

The bleed resistor (**16**) is a “controlled leak” from 0 to 12 l/min in response to circuit pressures from 0 to 100 cm H<sub>2</sub>O. The small quantity of pneumatic flow exhausting through the bleed resistor permits control of the exhalation valve's pilot pressure by modulation of the valve output. The bleed resistor exhausts only clean drive gas and must not be connected to a waste gas scavenging circuit. The output is routed away from the electrical components to make sure that systems using oxygen drive gas meet the 10VA limitation requirement for oxygen enrichment.

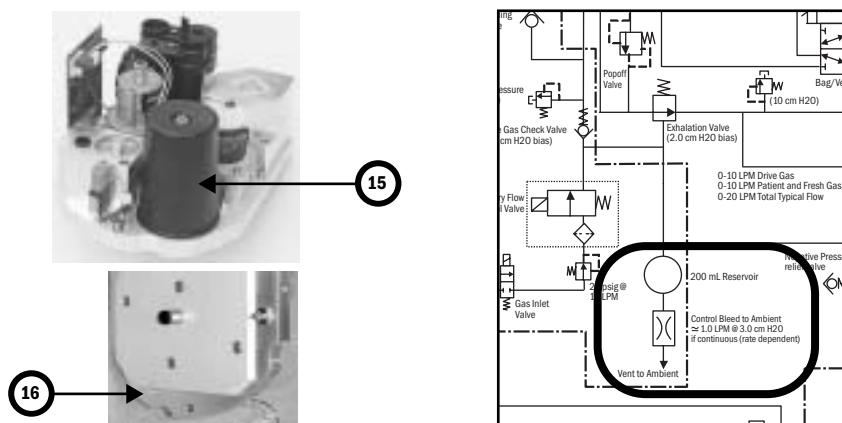


Figure 2-41 • Reservoir and bleed resistor

## 2.12.9 Free breathing valve

The free breathing valve (17) helps assure the patient can spontaneously breathe. The ventilator is programmed to supply a specified number of breaths per minute to the patient. If, in between one of these programmed cycles, the patient needs a breath (spontaneous), the free breathing valve permits the patient to inhale. The free breathing valve is closed on mechanical inspiration.

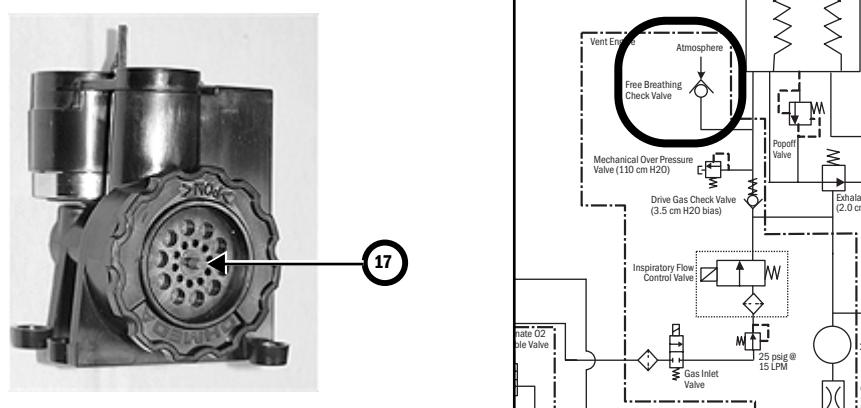


Figure 2-42 • Free breathing valve

## 2.12.10 Breathing circuit flow sensors

Two flow sensors are used to monitor inspiratory and expiratory gas flow. The inspiratory flow sensor is downstream of the gas system inspiratory check valve. Feedback from the inspiratory transducer is used to supply tidal volumes that make allowances for the effects of fresh gas flow and circuit compressibility. The expiratory flow sensor is located at the input to the gas system expiratory check valve. Feedback from the expiratory flow sensor is used to supply signals for expiratory tidal volume monitoring and the breath rate.

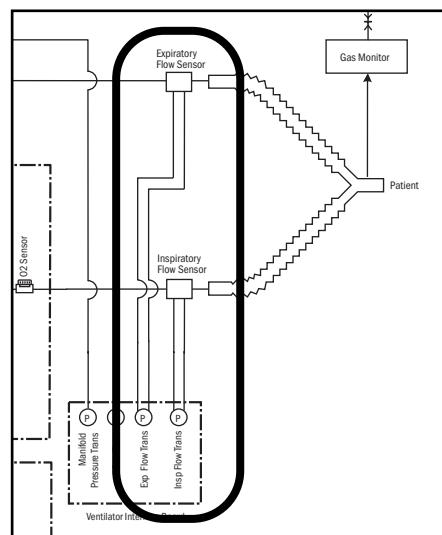


Figure 2-43 • Flow sensors

# 3 Checkout Procedure

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	3.2.1 Low P leak check .....	3-3
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**⚠️ WARNINGS** After any repair or service of the Avance system, complete all tests in this section.

Before you do the tests in this section:

- Complete all necessary calibrations and subassembly tests. Refer to the individual procedures for a list of necessary calibrations.
- Completely reassemble the system.

If a test failure occurs, make appropriate repairs and test for correct operation.

## 3.1 Inspect the system

**⚠ CAUTION** The upper shelf weight limit is 34 kg (75 lb).

**⚠ WARNING** Do not leave gas cylinder valves open if the pipeline supply is in use. Cylinder supplies could be depleted, leaving an insufficient reserve supply in case of pipeline failure.

Before testing the system, ensure that:

- The equipment is not damaged.
- Components are correctly attached.
- The breathing circuit is correctly connected, not damaged.
- Pipeline gas supplies are connected.
- Cylinder valves are closed.
- Models with cylinder supplies have a cylinder wrench attached to the system.
- Models with cylinder supplies have a reserve supply of O<sub>2</sub> connected to the machine during system checkout.
- The casters are not loose and the brakes are set and prevent movement.
- The power cord is connected to a wall outlet. The mains indicator comes on when AC Power is connected.

## 3.2 System “All checks”

On the system “Checkout” menu, select **All Checks** and follow the instructions for “Low P leak check”, “Quick check”, “Vent check”, and “Circuit O2 cell check”.

If a check fails, follow the instructions on the display to perform a recheck or accept the results.

### 3.2.1 Low P leak check

The low P leak check looks for leaks between the mixer, vaporizer, and the inspiratory side of the breathing circuit.

#### For machines with SCGO:

1. Ensure the vaporizers are turned off.
2. Plug the inspiratory (right-hand) port.
3. Select **Start**. The display shows the checks being run.
4. Repeat the check for each vaporizer with the vaporizer turned on.
5. When the checks pass, turn the vaporizer off.
6. Remove the plug from the inspiratory port.
7. Select **Next** to go to the next check.

#### For machines with ACGO:

1. Ensure the vaporizers are turned off.
2. Set the ACGO switch to ACGO.
3. Attach the “negative low-pressure leak test” device to the ACGO outlet.
4. Collapse the bulb (squeeze).
5. If the bulb inflates in < 30 seconds, there is a leak.
6. If the bulb remains collapsed, repeat the check for each vaporizer with the vaporizer turned on.
7. When the checks pass, turn the vaporizer off. Select **Pass** to go the next check.

### 3.2.2 Quick check

The quick check checks that the:

- Bag/Vent switch works in Bag position.
  - Gas supply pressures are OK.
  - Power cord is connected and the mains power is OK.
  - Battery is fully charged.
  - Manual circuit leak is OK.
  - Flow controls operate correctly.
1. Occlude the patient Y piece.
  2. Set the Bag/Vent switch to Bag.
  3. Set the ACGO switch to Circle (ACGO option only).
  4. Set the APL valve to approximately 50 (between the 30 and 70 marks).
  5. Select **Start**. The display shows the checks being run.
  6. When the checks pass, select **Next** to go to the next check.

### 3.2.3 Vent check

The vent check measures circuit compliance and checks that the:

- Bag/Vent switch works in Vent position.
  - Ventilator drive gas and O<sub>2</sub> pressure are OK.
  - Ventilator circuit leak is OK.
  - Ventilator delivers correctly.
  - Alarms for ventilator failure or problems do not occur.
1. Set the Bag/Vent switch to Vent.
  2. Open the patient Y piece.
  3. Set the ACGO switch to Circle (ACGO option only).
  4. Select **Start**. The display shows time remaining for check.
  5. When check passes, follow the instructions on the display.
  6. Make sure the bellows is collapsed.
  7. Occlude the patient Y piece.
  8. Select **Continue**. The display shows the checks being run.
  9. When the checks pass, the circuit compliance is displayed.
  10. Select **Next** to go to the next check.

### 3.2.4 Circuit O<sub>2</sub> cell check

The circuit O<sub>2</sub> cell check measures the O<sub>2</sub>%.

1. Unplug the patient Y piece.
2. Set the Bag/Vent switch to Vent.
3. Set the ACGO switch to Circle (ACGO option only).
4. The display will show the O<sub>2</sub>%.
5. Select **Exit** when measured O<sub>2</sub> is stable.  
O<sub>2</sub> cell calibration is recommended if displayed value is less than 21%.

### 3.3 Backlight test

1. Push the **Main Menu** key.
2. Select **Calibration**.
3. Select **Backlight Test**.
4. Select **Start Test**.
5. The display will show the test running on light 1 and then on light 2. If the display goes completely blank or flickers during the test, one of the lights has failed.

### 3.4 Vaporizer back pressure test

**WARNING** Anesthetic agent comes out of the circuit during this test. Use a safe, approved procedure to collect and remove the agent.

1. Set the System switch to On.
2. Set the O<sub>2</sub> flow to 6 l/min.
3. Slowly adjust the vaporizer concentration from 0 to 1%.
  - Make sure that the O<sub>2</sub> flow stays constant.
  - Verify that the system continues to operate without issuing any related alarms.
4. Repeat the test for both vaporizer positions.

## 3.5 Pipeline and cylinder tests

1. Connect the pipeline supplies one at a time and ensure that the corresponding display indicates pipeline pressure.
2. Disconnect all pipeline supplies.
  - a. Open each cylinder valve.
  - b. Make sure that each cylinder has sufficient pressure. If not, close the applicable cylinder valve and install a full cylinder.
3. Test the cylinder supplies for a high pressure leak. Make sure that each cylinder has sufficient pressure:
  - a. If equipped, turn the auxiliary O<sub>2</sub> flow control fully clockwise (no flow).
  - b. If equipped, turn off venturi derived suction.
  - c. Open each cylinder.
  - d. Record the cylinder pressure.
  - e. Close each cylinder valve.
  - f. Record the cylinder pressure after one minute. If the pressure decreases more than indicated below, there is a leak.

**5000 kPa (725 psig)** for ventilator drive gas.

**690 kPa (100 psig)** for non ventilator drive gas.

If a cylinder supply fails this test, install a new cylinder gasket and do this step again.

4. Close all cylinder valves.

### **WARNING**

Do not leave gas cylinder valves open if the pipeline supply is in use. Cylinder supplies could be depleted, leaving an insufficient reserve supply in case of pipeline failure.

### 3.5.1 O<sub>2</sub> supply alarm test

1. Establish O<sub>2</sub>, Air, and (if equipped) N<sub>2</sub>O gas supplies.
2. Set O<sub>2</sub> to 25% and (if equipped) N<sub>2</sub>O as balance gas. For machines without N<sub>2</sub>O, set Air as balance gas.
3. Set total flow to 3 L/min.
4. Stop the O<sub>2</sub> supply. (Disconnect the pipeline supply or close the cylinder valve.)
5. Make sure that:
  - a. The low “O<sub>2</sub> supply pressure low” alarm occurs.
  - b. The N<sub>2</sub>O (if equipped) and O<sub>2</sub> flows stop.
  - c. Air (if selected) flow continues or an Air selection prompt appears.

## 3.6 Pressure relief tests

To check the pressure relief valve in the vaporizer manifold outlet.

### For machines with SCGO:

1. Remove the back cover to access the vaporizer manifold.
2. Remove the outlet tubing and connect a test device (pressure gauge or a digital manometer) to the vaporizer manifold outlet.
3. Adjust the O<sub>2</sub> flow to 0.5 L/min.
4. Verify that the test device reading stabilizes within the following range:  
**31–60 kPa (230–450 mm Hg) (4.5–8.5 psi).**
5. Remove the test device and reconnect the outlet tubing.
6. Replace the back cover.

### For machines with ACGO:

1. Set the ACGO selector switch to ACGO.
2. Connect a test device (pressure gauge or a digital manometer) to the ACGO outlet using the positive pressure leak test adapter.
3. Adjust the O<sub>2</sub> flow to 0.5 L/min.
4. Verify that the test device reading stabilizes within the following range:  
**31–60 kPa (230–450 mm Hg) (4.5–8.5 psi).**
5. Remove the test device and the adapter.

Test Adapter

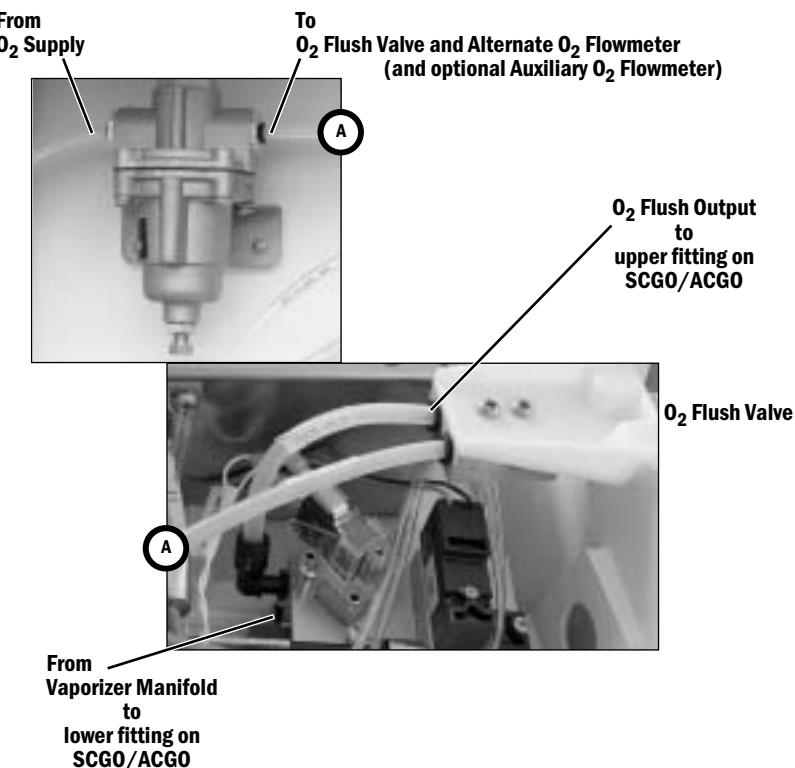


## 3.7 Flush Flow Test

1. Set the Bag/Vent switch to Vent.
2. Set the system switch to Standby.
3. Attach a patient circuit and plug the patient port.
4. For ACGO equipped machines, set the ACGO selector switch to ABS.
5. Ensure that the bellows is completely collapsed.
6. Measure the amount of time it takes to fill the bellows when the O<sub>2</sub> Flush button is fully and continuously depressed.
7. Repeat the above measurement two more times (deflate bellows by removing the plug from the patient port).
  - The bellows should fill in 1.8 to 2.3 seconds.

### Possible Causes of Failure

- Large leak (if long filling time).
- Flush regulator setting (Section 5.2).
- Flush regulator cross-connection (if long filling time).
- SCGO/ACGO selector valve inlet cross-connection (if short filling time).



## 3.8 Alarm tests

1. Connect a test lung to the patient connection.
2. Start a case.
3. Set the Bag/Vent switch to Vent.
4. Set the O<sub>2</sub> concentration to 30%, and allow the O<sub>2</sub> reading to stabilize.
5. Test the O<sub>2</sub> alarms:
  - Set the ***FiO2 low*** alarm limit to 50%. Make sure an ***FiO2 low*** alarm occurs.
  - Set the ***FiO2 low*** alarm limit back to 21% and make sure that the ***FiO2 low*** alarm cancels.
  - Set the ***FiO2 high*** alarm limit to 50%.
  - Push the O<sub>2</sub> flush button.
  - Make sure the ***FiO2 high*** alarm occurs.
  - Set the ***FiO2 high*** alarm limit back to 100%. Make sure that the ***FiO2 high*** alarm cancels.
6. Test the ***MVexp low*** alarm:
  - Go to the **Alarm Setup** menu.
  - Set the ***MV low*** alarm limit to greater than the measured minute volume.
  - Make sure that a ***MVexp low*** alarm occurs.
  - Set the ***MV low*** alarm limit to off.
7. Test the ***Ppeak high*** alarm:
  - Set the ***Pmax*** to less than the peak airway pressure.
  - Make sure that the ***Ppeak high*** alarm occurs.
  - Set the ***Pmax*** to the desired level.
8. Test the ***PEEP high. Blockage?*** alarm:
  - Close the APL valve.
  - Set the Bag/Vent switch to Bag. Mechanical ventilation stops.
  - Block the patient connection and push the O<sub>2</sub> flush button.
  - Make sure that the ***PEEP high. Blockage?*** alarm occurs after approximately 15 seconds.
9. Test the ***Apnea*** and ***Ppeak low. Leak?*** alarms:
  - Unblock the patient connection.
  - Set the Bag/Vent switch to Vent.
  - Set the tidal volume and total flow to minimum.
  - Other alarms such as ***MVexp low*** can occur.
  - Make sure that the ***Apnea*** and ***Ppeak low. Leak?*** alarms occur.
10. Set all alarm limits to approved clinical values.

### **3.9 Alternate O<sub>2</sub> flowmeter tests**

1. Open the O<sub>2</sub> cylinder valve or connect an O<sub>2</sub> pipeline.
2. Rotate the Alt O<sub>2</sub> flow control fully clockwise to minimum flow.
3. Press the Alternate O<sub>2</sub> switch to turn on Alternate O<sub>2</sub> flow.  
The flowmeter should indicate 0.5 to 0.7 L/min.
4. Rotate the flow control counterclockwise (increase). The ball should rise immediately after rotation is begun. It should rise smoothly and steadily with continued counterclockwise rotation. When a desired flow is set, the ball should maintain in a steady position.
5. Rotate the flow control clockwise to minimum flow.
6. Press the Alternate O<sub>2</sub> switch to turn off Alternate O<sub>2</sub> flow; confirm yes.

### **3.10 Auxiliary O<sub>2</sub> flowmeter tests**

1. Open the O<sub>2</sub> cylinder valve or connect an O<sub>2</sub> pipeline.
2. Rotate the flow control clockwise (decrease) to shut off the flow. The ball should rest at the bottom of the flow tube and not move.
3. Rotate the flow control counterclockwise (increase). The ball should rise immediately after rotation is begun. It should rise smoothly and steadily with continued counterclockwise rotation. When a desired flow is set, the ball should maintain in a steady position.
4. Occlude the auxiliary O<sub>2</sub> outlet. The ball should rest at the bottom of the flow tube and not move. A ball that does not rest at the bottom of the flow tube indicates a leak and requires service.
5. Rotate the flow control clockwise to shut off the flow.

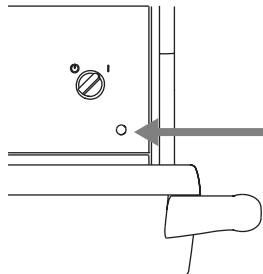
### **3.11 Integrated Suction Regulator tests**

The gauge needle should come to rest within the zero range bracket when no suction is being supplied. Gauges which do not comply may be out of calibration.

1. Adjust the regulator setting to minimum.
2. Turn the mode selector to I (On).
3. Ensure the gauge remains less than 200 mmHg (26 kPa, 0.26 Bar).
4. Occlude the inlet.
5. Ensure the gauge remains less than 200 mmHg (26 kPa, 0.26 Bar).
6. Adjust the regulator in an increasing vacuum level.
7. The gauge should rise after rotation has begun. The gauge should rise with continued rotation of the regulator adjustment.
8. Adjust the regulator setting to minimum.
9. Turn the Mode selector to O (Off).

## 3.12 Power failure test

1. Connect the power cord to a wall outlet. The mains indicator on the front panel comes on when AC Power is connected.



2. Set the system switch to On and Start a case.
3. Unplug the power cord with the system turned on.
4. Make sure that the power failure alarm comes on.
5. Make sure the following message is displayed:
  - Plug in power cable. On battery
6. Connect the power cable again.
7. Make sure the alarm cancels.

## 3.13 Electrical safety tests

Make sure the system is completely assembled and all accessory devices are connected to electrical outlets.

1. Connect an approved test device (e.g. UL, CSA, or AAMI) and verify that the leakage current is less than:

Voltage	Max. Leakage Current
120/100 Vac	300 µAmps
220/240 Vac	500 µAmps

2. Make sure that the resistance to ground is less than  $0.2\Omega$  between an exposed metal surface and the ground pin on the power cord.

## Notes

# 4 Installation and Service Menus

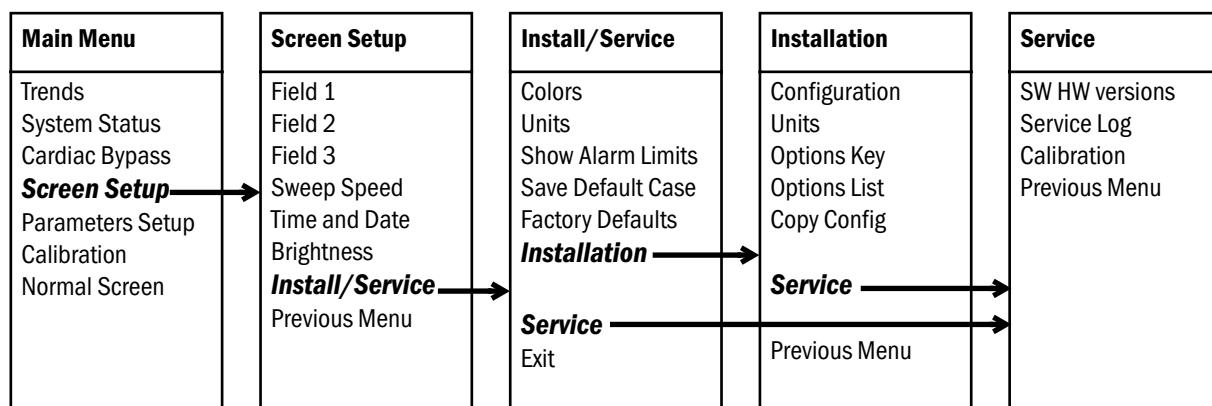
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## 4.1 Service and Installation menu structure

This section describes the Service level functions that are part of the main software installed in the anesthesia machine.

Section 8, “Service Diagnostics and Software Download,” covers a separate service application that loads from a PCMCIA card and is used to download system software and run service diagnostics and other service tests.

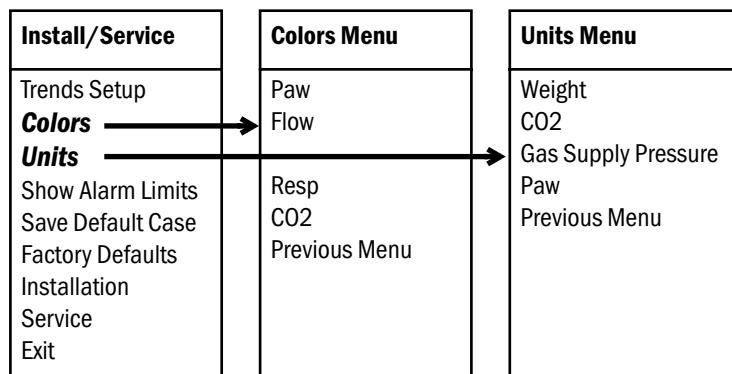
- |                       |                                                                           |
|-----------------------|---------------------------------------------------------------------------|
| <b>Menu structure</b> | The Service menu structure has three levels which are password protected: |
|-----------------------|---------------------------------------------------------------------------|
- Install/Service (super-user)
  - Installation
  - Service
- The **Install/Service** level (super-user password) supports standard hospital preferences: choosing units; setting ventilator, alarm, and gas delivery defaults.
- The **Installation** level requires the service password and supports language, gas color codes, flow tube position, country, hardware flags for system components (acgo or scgo etc.), enabling software options, and cloning a system.
- The **Service** level requires the service password and supports diagnostic tools and automated component tests.
- Follow the menu structure to access the various service screens:
- on the **Main Menu**, select **Screen Setup**;
  - on the **Screen Setup** menu, select **Install/Service** to access the Install/Service (with super-user password) menu;
  - on the **Install/Service** menu, select **Installation** (with service password) to access the Installation menu.
  - to access the Service menu, select **Service** (with service password) on the **Install/Service** menu; or, from the **Installation** menu, select **Service** to access the same Service menu without having to enter the service password.



## 4.2 Install/Service Menu (Super User)

Use the super-user password to access the Install/Service menu:  
“16-4-34.”

Menu Item	Message text	Comments
Colors	Set colors of parameters.	
Units	Set units of weight, CO2, gas supply pressure, and Paw.	
Show Alarm Limits	Select yes to show alarm limits in digit fields.	Default is Yes
Save Default Case	Save normal screen, air/ N2O, circuit type, ventilator settings, and alarm limits from the last case as defaults	Last used alarm settings (including hide/show alarm limits), screen layout (middle waveform selection, sweep speed, scaling), ventilator mode and setting, balance gas, and start case gas outlet selection are saved as facility defaults. <b>Note:</b> The Pmax alarm limit shall not be saved higher than 40 cmH2O. The low FiO2 alarm limit shall not be saved lower than 21%.
Factory Defaults	Return to default factory settings.  After selecting Factory Defaults: “Reset machine for defaults to take effect.”	Action: All facility defaults get replaced with factory defaults. Super User settings also get set to Factory Defaults. No Service level configuration settings are changed.
Installation	Set language, gas colors, hardware, and enable options.	Navigate with password to Installation menu. Password is “26-23-8”
Service	Show technical data for troubleshooting and calibration.	Navigate with password to Service menu. Password is “26-23-8”
Exit	Turn power off to exit the service and super user menus.	



### 4.2.1 Colors Menu

Menu Item	Message text	Values
Paw	Change color of Paw waveform, digits and trend.	Yellow, White, Green, Red, or Blue
Flow	Change color of Flow waveform, Flow and Volume digits and trends.	Yellow, White, Green, Red, or Blue
Resp	Change color of respiration, digits and trend.	Yellow, White, Green, Red, or Blue
CO2	Change color of CO2 waveform, digits and trend.	Yellow, White, Green, Red, or Blue
Previous Menu	Return to previous menu.	

### 4.2.2 Units Menu

The Units menu can be accessed here in the super-user level to change individual preferences, or if required during installation, in the service level Installation menu.

Menu Item	Message text	Values
Weight	Change weight unit: kg or lb.	kg or lb
CO2	Change CO2 unit: %, kPa, or mmHg.	%, kPa, or mmHg;
Gas Supply Pressure	Change gas supply pressure unit: kPa, psi, or bar.	psi, kPa, or bar
Paw	Change Paw unit: kPa, hPa, cmH2O, mmHg, mbar.	kPa, hPa, cmH2O, mmHg, or mbar
Previous Menu	Return to previous menu.	

### 4.2.3 Factory Defaults

The following table lists the factory defaults for parameters and alarm limits:

Parameter	Value	Alarm Limit	Value
Vent Mode	VCV	Pmax High	40 cmH2O (40 hPa, 4 kPa, 40 mbar, 30 mmHg)
TV (tidal volume)	500 ml	MV High	10 l/min
Pinsp	5 cmH2O (5 hPa, 0.5 kPa, 5 mbar, 3.6 mmHg)	MV Low	2 l/min
RR	12 /min	TV High	1000 ml
Mech RR	12 /min	TV Low	Off
Tinsp	1.70	RR High	Off
I:E	1:2.0	RR Low	Off
Trig. Window	25%	Et CO2 High	6.5% (50 mmHg or 6.5kPa)
Flow Trig.	2 l/min	Et CO2 Low	Off
End Breath	25%	Fi CO2 High	Off
Psupport	Off	Fi O2High	Off
PEEP	Off	Fi O2 Low	21%
Tpause	Off	Et O2 High	Off
Backup Time	30 s	Et O2 Low	Off
O2%	100%	Fi Iso High	5%
Balance Gas	Air	Fi Iso Low	Off
Circuit	Circle	Et Iso High	Off
Gas Outlet installed	SCGO	Et Iso Low	Off
Paw Color	Yellow	Fi Sev High	8%
Flow Color	Green	Fi Sev Low	Off
Resp Color	White	Et Sev High	Off
CO2 Color	White	Et Sev Low	Off
Paw Units	cmH2O	Fi Des High	15%
Weight Units	kg	Fi Des Low	Off
Temperature Units	C	Et Des High	Off
CO2 Units	%	Et Des Low	Off
Altitude	300 m	Fi Enf High	5%
Gas Supply Pressure Units	kPa	Fi Enf Low	Off
Decimal marker	. <dot>	Et Enf High	Off
Language	English	Et Enf Low	Off
Gas Supply Colors	ISO (O2 = white, N2O = blue, Air = blk/wht)	Fi Hal High	5%
O2 flow tube	Right side	Fi Hal Low	Off
Vent drive gas	O2	Et Hal High	Off
PSV Pro	Enabled	Et Hal Low	Off
SIMV/PSV	Enabled		
PCV	Enabled		
SIMV-PC	Enabled		
N2O enabled	No		

## 4.3 Installation Menu

Use the service-level password to access the Installation menu:  
“26-23-8.”

Whenever the installation menu is entered, “Enter Service dd-mmm-yyyy  
hh:mm:ss” is recorded in the Event log.

Menu Item	Message text
Configuration	Set language, gas color code, and O2 flowmeter position.
Units	Set units.
Options Key	Enable software options.
Options List	Display software options.
Copy Config	Normal Message “Save or install configuration and default settings using memory card.”  Blocked Message “Please insert memory card.”
Service	Show error, event, and alarm logs. (Accessing the Service menu from the Installation menu does not require second use of service password.)
Previous Menu	Return to previous menu.

Configuration	Units Menu	Options Key	Options List	Copy Configuration
Decimal Marker Language Gas supply Colors O2 Flowtube Ventilator Drive Gas Altitude Gas Outlet N2O Enabled	Weight CO2 Gas Supply Pressure Paw	Current Key Entry 1 Entry 2 Entry 3 Entry 4 Entry 5 Entry 6 Entry 7 Save New Key Control Board ID	Available Options SIMV/PSV PCV PSV Pro	Save to Card Copy from Card

### 4.3.1 Configuration

Menu Item	Message text	Values	Comments
Decimal Marker	Select decimal delineator.	0,01, ,01 or ,0,01	
Language	Change language translation of screen texts.	English, French, German, Spanish, Italian, Japanese, Portuguese, Dutch, Chinese (simplified), Finnish, Norwegian, Hungarian, Polish, Greek, Czech, Turkish, and Russian.	Default: English
Gas supply Colors	Change color of O2, N2O, and Air.	ANSI, ISO, Neutral	ANSI: O2 green, Air yellow, N2O blue; ISO: O2 white, Air black/white, N2O blue; Neutral: All gases white.
O2 Flowtube	O2 on left or right-hand side.	Left, Right	
Ventilator Drive Gas	Change drive gas to match machine configuration.	Air, O2	
Altitude	Change altitude used for gas calculations.	-400 to 3000 m in 100-m increments	
Gas Outlet*	Change type of fresh gas outlet.	SCGO, ACGO	SCGO: Use insp port. ACGO: Use auxiliary port.
N2O Enabled	Change to match machine configuration.	Yes; No	

\* For machines without a separate auxiliary common gas outlet and selector switch, set **Gas Outlet** to SCGO: Selectable Common Gas Outlet.

\* For machines with an external auxiliary common gas outlet and selector switch, set **Gas Outlet** to ACGO: Auxiliary Common Gas Outlet

### 4.3.2 Units Menu

This is the same menu that is accessible from the super-user Install/Service menu.

Menu Item	Message text	Values
Weight	Change weight unit: kg or lb.	kg or lb
CO2	Change CO2 unit: %, kPa, or mmHg.	%, kPa, or mmHg
Gas Supply Pressure	Change gas supply pressure unit: kPa, psi, or bar.	psi, kPa, bar
Paw	Change Paw unit: kPa, hPa, cmH2O, mmHg, mbar.	kPa, hPa, cmH2O, mmHg, or mbar

### 4.3.3 Options Key

The Options Key menu is used to configure the software to include the features that the customer has purchased. The included features are shown in the Options List menu.

#### Options Key menu

Menu Item	Message text	Values
Current Key	Enter key code to enable options.	XXXAXBC
Entry 1	Enter first entry of key-code.	0 to 9, A to Z, ~, !, @, #, \$, %, ^, *, (,), ?
Entry 2	Enter second entry of key-code.	
Entry 3	Enter third entry of key-code.	
Entry 4	Enter fourth entry of key-code.	
Entry 5	Enter fifth entry of key-code.	
Entry 6	Enter sixth entry of key-code.	
Entry 7	Enter seventh entry of key-code.	
Save New Key	Confirm entries for key-code.	
Control Board ID	Control number used by key-code.	XXX

When options are added, “Add <option> dd-MMM-yyy hh:mm:ss” is written to the event log.

If more than one option is added, each option is listed separately.

**Options List menu** The options list shows which options are enabled.

Menu Item	Message text	Values
Available Options		
SIMV/PSV	SIMV vent w/pressure support.	On, Off
PCV	Pressure controlled ventilation.	On, Off
PSV Pro	Pressure support ventilation w/backup.	On, Off

#### 4.3.4 Copy Configuration

##### Copy Configuration menu

Menu Item	Message text	Values	Comments
Save to Card	Save Configuration and defaults to card.  The field is blank until the data has either been written to the card (OK) or the system determines it cannot write to the card (Fail).	<blank>, Fail, or OK.  The field is blank until the data has either been written to the card (OK) or the system determines it cannot write to the card (Fail).	Saves all settings that are not hardware dependent, including facility defaults, colors, units, O2 flow tube position, decimal marker, and altitude.
Copy from Card	Copy Configuration and defaults from card.  When completed: Copy from card complete. Please reboot system.	<blank>, Fail, or OK.  The field is blank until the data has either been read from the card (OK) or the system determines it cannot read the card or the card does not have the required data (Fail).	

Systems cannot accept configuration files from a different product model.

The software version is stored with the saved configuration. A system will reject any configurations from other than the current version of software.

Selecting Save to Card overwrites any configuration on the card.

## 4.4 Service Menu

Use the service-level password to access the Service menu:  
“26-23-8.”

Whenever service menu is entered, “Enter Service dd-mmm-yyyy hh:mm:ss”  
is recorded in the Event log.

Menu Item	Message text
SW HW versions	Scroll through system information.
Service Log	Show error, event, and alarm histories.
Calibration	Push ComWheel to perform service calibrations.
Previous Menu	Return to previous menu.

SW HW Versions	Service Log Menu	Calibration
Total Time: Software Release: Model Code: Machine Serial Number: Option Package: Option Code: Anes Hardware . . . Disp Hardware . . . Mixer Hardware . . . Vent Hardware . . . Power Hardware . . . MGas Hardware . . .	Scroll Recent Error History Event History Alarm History Copy Logs Reset Logs Previous Menu	Instructions User Calibration Manifold P Span Insp Flow Zero Insp Flow Valve Bleed Resistor Paw Span Zero Gas Xducer Cal Config Previous Menu

#### **4.4.1 Software/ Hardware Ver Menu**

Turn the ComWheel to scroll through the list box.

Push the ComWheel to return to the Service menu.

#### **System Information menu**

List box text with X=Number, A, B, C = letter
Total Time: XXXXX (Minutes)
Software Release: XX.XX
Model Code: XXX
Machine Serial Number: ABCDXXXX
Option Package: XXX
Options Code: XXXXX
Anes Software Version: XX.XX
Anes Hardware Version: XXXX-XXXX-XXX REV A
Anes Board Serial Number: ABCXXXX
Disp Software Version: XX.XX
Disp Hardware Version: XXXX-XXXX-XXX REV A
Disp Hardware Serial Number: ABCXXXX
Mixer Software Version: XX.XX
Mixer Hardware Version: XXXX-XXXX-XXX REV A
Mixer Board Serial Number: ABCXXXX
Mixer O2 Flow Sensor Serial Number: XXXXXXXXX
Mixer Balance Gas Flow Sensor Serial Number: XXXXXXXXX
PCA Serial Number: ABCXXXX
Vent Software Version: XX.XX
Vent Hardware Version: XXXX-XXXX-XXX REV A
Vent Intf Board Serial Number: ABCXXXX
Power Software Version: XX.XX
Power Hardware Version: XXXX-XXXX-XXX REV A
Power Board Serial Number: ABCXXXX
MGas Software Version: X.X
MGas Hardware Version: GAS SW Pr. XXXXXXX-X
MGas Hardware Serial Number: ABCXXXX

The MGas information is only displayed when an Airway module is present.

#### 4.4.2 Service Log Menu

The Service log menu is a organized listing of stored events.

Menu Item	Message text
Scroll Recent	Scroll through newest entries.
Error History	Show error history.
Event History	Show event history.
Alarm History	Show alarm history.
Copy Logs	Copy logs to PCMCIA card. Takes about 1 minute.
Reset Logs	Erase Error and Alarm log entries
Previous Menu	Return to previous menu.

Each history log shows at the top of the screen the total “Running Hours” and the date when the logs were last reset. The running hours number is the same number as the operating hours shown on the system status page during normal operation.

Whenever logs are reset, “Reset Logs dd-MMM-yyy hh:mm:ss” is recorded in the Event log.

If the logs are saved to a memory card, the machine’s serial number is saved along with the current contents of the logs and the date and time.

##### Error History ◀

The Error History log list the last 200 errors logged since the last log reset, starting with the most recent. The system stores the last 1,000 errors logged since the last log reset.

##### Event History ◀

The Event History log records the service history of the device. This includes: service calibrations, entry into the service mode, options enabled, and software installation. In the event of a board replacement, it is understood that this log like all others could be lost.

The Event History menu lists the last 200 events logged starting with the most recent. The Event History log stores the last 1000 events.

The Event History log cannot be reset.

##### Alarm History ◀

The Alarm History log lists the last 200 medium and high priority parameter alarms since the last log reset starting with the most recent. The Alarm History log store the last 1000 entries.

##### Copy Logs

The Copy Logs function copies Error, Event, and Alarm logs along with the software/hardware configuration to a text file on a PCMCIA card. The copying takes about one minute.

**4.4.3 Calibration**

For step-by-step instruction, refer to Section 5.

Menu Item	Message text
Instructions	
User Calibration	Show the normal user calibration menu.
Manifold P Span	Calibrate manifold pressure transducer.
Insp Flow Zero	Zero inspiratory flow valve.
Insp Flow Valve	Calibrate inspiratory flow valve.
Bleed Resistor	Calibrate bleed resistor flow.
Paw Span	Calibrate the airway pressure transducer.
Zero Gas Xducers	Calibrate the gas supply transducers.
Cal Config	Set vent drive gas and altitude.
Previous Menu	Return to previous menu.

**User Calibration menu**

Menu Item	Message text
Flow and Pressure	Calibrate the flow and pressure sensors.
Circuit O2 Cell	Calibrate Circuit O2 Cell.
Airway Gas	Start Gas Calibration. Calibrate CO2, O2, N2O, and agent measurements.
Backlight Test	Push ComWheel to test back lights. Test every month.
Previous Menu	Return to the previous menu.

#### 4.4.4 Manifold P Span

The Manifold P Span instructions appear when the focus is on Manifold P Span menu item.

##### Instructions

Read all steps before you start:

1. Remove the breathing system, the exhalation valve, and the metal plate.
2. Put #2 plugs in the manifold and the drive gas ports of the vent engine.
3. Connect a pressure gauge in line with the manifold pressure transducer.
4. Push the ComWheel to continue.
5. Select Start Manifold P Span.
6. Increase the Flow valve setting until the gauge shows 100 cmH2O.
7. When the gauge shows 100 cmH2O, select Save Calibration.

##### Manifold P Span menu

Menu Item	Message text	Values/ Comments
Insp Flow Valve (DAC)	Increase setting until test gauge shows 100 cmH2O (approx 1020 counts). Then save calibration.	0 to 4095  Disabled until user selects Start Manifold P Span.
Start Manifold P Span	Start Calibration. Increase flow valve setting until test gauge = 100 cmH2O (approximately 1020 counts). Then save calibration.  Blocking message: “Connect a supply of the drive gas to continue.”	Blocked when the ventilator drive gas supply pressure would cause a gas supply failure alarm during normal operation.
Save calibration	Save Manifold P Span calibration.	
Previous Menu	Return to the previous menu.  During calibration: “Calibration in progress. Push ComWheel to cancel.”	

#### 4.4.5 Insp Flow Zero

The Insp Flow Zero instructions appear when the focus is on the Insp Flow Zero menu item.

##### Instructions

Read all steps before you start:

1. Push the ComWheel to start the zero check
2. No disassembly is required.

- If the outcome of the calibration is Pass, the new calibration data is saved.
- If the outcome is Fail, the old calibration data is retained.
- The result of the calibration is saved to the Event Log.

Selecting Previous Menu before the calibration is done aborts the calibration in progress and keeps the old calibration constants.

##### Insp Flow Zero menu

Menu Item	Message text	Values
Start	If the result is failed, do the insp flow valve calibration.	Pass or Fail
Previous Menu	Return to previous menu.  During Calibration: “Calibration in progress. Push ComWheel to cancel.”	

#### **4.4.6 Inspiratory Flow Valve**

The Inspiratory Flow Valve instructions appear when the focus is on the Insp Flow Valve menu item.

##### **Instructions**

Read all steps before you start:

1. Complete the Manifold P Span calibration.
2. Put #2 plugs in the manifold and the drive gas ports of the vent engine.
3. Push the ComWheel to show the next menu.
4. Select Stage 1 calibration.
5. After Pass, replace the manifold port plug with the calibration orifice.
6. Select Stage 2 calibration.
7. You MUST do both stages for the calibration to be saved.

During calibration, a separate menu shows the counts and corresponding flow at each step.

- If the outcome of both stages of the calibration is Pass, the new calibration data is saved.
- If the outcome of either stage is Fail, the old calibration data is retained.
- The results of each stage of the calibration are saved to the Event Log.

Selecting Previous Menu before the calibration is done, aborts the calibration in progress and keep the old calibration constants.

**Insp Flow Valve Menu**

Menu Item	Message text	Comments
Stage 1	Calibrate the insp flow valve at low flows.  Blocked text: “Connect a supply of the drive gas to continue.”	Blocked if the ventilator drive gas supply pressure would cause a gas supply alarm during normal operation.
Stage 2	Calibrate the insp flow valve at high flows.  Blocked text: “Stage 1 calibration is required first.”	Blocked if Stage 1 has not been completed.
Insp Flow Valve Data	Show insp flow valve calibration table.	
Previous Menu	Return to previous menu.  During Calibration: “Calibration in progress. Push ComWheel to cancel.”	

**Insp Flow Valve Data menu**

The Insp Flow Valve Data menu contains a table of 24 entries from the previous calibration. The table is erased at the start of Stage 1. The table is update in real time during the calibration.

#### 4.4.7 Bleed Resistor

The Bleed Resistor instructions appear when the focus is on the Bleed Resistor menu item.

##### Instructions

Read all steps before you start:

1. Complete the Insp Flow Valve calibration.
2. Put #2 plugs in the manifold and the drive gas ports of the vent engine.
3. Push the ComWheel to show the next menu.
4. Select Start.

The calibration fails if the flow required to reach 91 cmH<sub>2</sub>O is > 16 l/min.

- If the outcome of the calibration is Pass, the new calibration data is saved.
- If the outcome is Fail, the old calibration data is retained.
- The result of the calibration is saved to the Event Log.

Selecting Previous Menu before the calibration is done aborts the calibration in progress and keep the old calibration constants.

##### Bleed Resistor Menu

Menu Item	Message text	Comments
Start	Calibrate manifold pressure to bleed resistor flow.  Blocked text: “Connect a supply of the drive gas to continue.”	Blocked if the ventilator drive gas supply pressure would cause a gas supply failure alarm during normal operation.
Bleed Resistor Data	Show bleed resistor calibration table.	
Previous Menu	Return to the previous menu.  During Calibration: “Calibration in progress. Push ComWheel to cancel.”	

##### Bleed Resistor Data menu

The Bleed Resistor Data menu contains a table of 17 entries from a previous calibration. The table is erased at the start of the calibration. The table is update in real time during the calibration.

#### 4.4.8 Paw Span

The Airway P Span instructions appear when the focus is on Paw Span menu item.

##### Instructions

- Read all steps before you start:
1. Complete the Bleed Resistor calibration.
  2. Install the flow sensor and circuit module
  3. Put a #2 plug in the drive gas port of the vent engine.
  4. Put the calibrated orifice in the manifold port of the vent engine.
  5. Connect the pressure tee to the insp port. Connect the tee to the calibrated orifice with a 22 mm tube.
  6. Connect a pressure gauge to the pressure tee.
  7. Select Start Paw Span.
  8. Increase the flow valve setting until the gauge shows 100 cmH2O.
  9. Select Save Calibration

##### Paw Span menu

Menu Item	Message text	Values/Comments
Insp Flow Valve (DAC)	Increase setting until test gauge shows 100 cmH2O (approximately 1020 counts). Then save calibration.	0 to 4095 (initially set to 800)
Start Paw Span	Start Calibration. Increase flow valve setting until test gauge = 100 cmH2O (approximately 1020 counts). Then save calibration.  Blocked text: Connect a supply of the drive gas to continue.	Blocked if the ventilator drive gas supply pressure would cause a gas supply failure alarm during normal operation.
Save calibration	Save Paw Span calibration.	Saves new calibration data. Writes calibration result, date and time to the event log.
Previous Menu	Return to the previous menu.  During Calibration: “Calibration in progress. Push ComWheel to cancel.”	

#### 4.4.9 Zero Gas Xducer

The Zero Gas Xducer instructions appear when the focus is on the Zero Gas Xducer menu item.

##### Instructions

Read all steps before you start:

1. Remove all cylinders.
2. Disconnect all pipeline supplies.
3. Select Zero Gas Xducers.
4. Select Start Zero on the next menu.

This page also shows:

- Gas supply pressures
- Gas supply ID

A failed test is usually the result of a pipeline or cylinder still connected to the system.

- If the outcome of the calibration is Pass, the new calibration data is saved.
- If the outcome is Fail, the old calibration data is retained.
- The result of the calibration is saved to the Event Log.

Selecting Previous Menu before the calibration is done aborts the calibration in progress and keep the old calibration constants.

##### Zero Gas Xducers menu

Menu Item	Message text	Values
O2 Pipeline		0-4095 Counts
O2 Cylinder 1		0-4095 Counts
O2 Cylinder 2		0-4095 Counts
N2O Pipeline		0-4095 Counts
N2O Cylinder		0-4095 Counts
Air Pipeline		0-4095 Counts
Air Cylinder		0-4095 Counts
Start Zero	Disconnect all pipelines and remove cylinders. Then select Start Zero.	
Previous Menu	Return to the previous menu. During Calibration: “Calibration in progress. Push ComWheel to cancel.”	

#### 4.4.10 Cal Config

Before calibration, you must verify that the Ventilator Drive Gas and the Altitude settings are set appropriately to match the current drive gas configuration and machine location.

If you change any of the settings in the Cal Config menu, you must restart the system.

##### Cal Config menu

Menu Item	Message text	Values
Ventilator Drive Gas	Change drive gas to match machine configuration.	Air, O2
Altitude	Change altitude used for gas calculations.	-400 to 3000 m (in 100-m increments)

## Notes

# 5 Calibration

 **WARNING** After adjustments and calibration are completed, always perform the checkout procedure. Refer to Section 3 of this manual.

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## 5.1 Primary Regulators

Follow the procedure in Section 5.1.1 to gain access to the regulators. Then, in Section 5.1.2, select the test that is appropriate for the regulator you are testing.

**⚠ WARNING** When testing/adjusting N<sub>2</sub>O regulators, nitrous oxide flows through the system. Use a safe and approved procedure to collect and remove it.

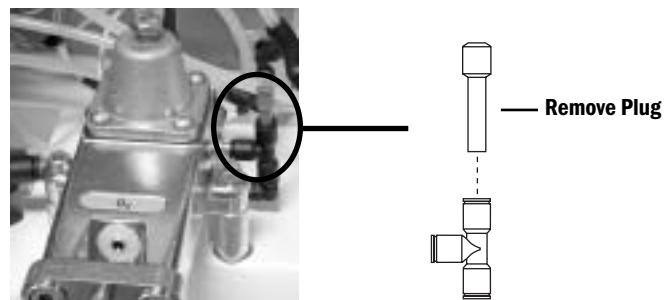
To test or calibrate the primary regulators, you must boot the system with the PCMCIA Service Application and access the Gas Diagnostics function as detailed in Section 8.

### 5.1.1 Test setup

**⚠ WARNING** Wear safety glasses while test device is connected to the test port.

**⚠ CAUTION** Be careful not to plug the output of the primary regulator without having a pressure relief valve in the output circuit.

1. Set the system switch to Standby.
2. Disconnect all pipeline supplies.
3. Remove the upper rear panel (Section 9.2).
4. If equipped, turn the auxiliary O<sub>2</sub> flowmeter control fully clockwise (no flow).
5. Install a full cylinder in the cylinder supply to be tested. It is essential that the cylinder be within 10% of its full pressure.
6. Remove the plug from the test port and connect a test device capable of measuring 689 kPa (100 psi).



### 5.1.2 Testing Primary Regulators

There are two variations of the test procedure for the primary regulators:

- Test A – For primary regulators that supply drive gas to the ventilator.
- Test B – For all gases not used to supply drive gas to the ventilator.

**Test A For primary regulators that supply drive gas to the ventilator (O<sub>2</sub> or Air):**

Under low flow conditions, the output pressure of a properly adjusted/ functioning regulator should fall within specifications listed in step 4e.

Under high flow conditions, the output pressure should not drop below the specifications listed in step 5g.

1. On the Main Menu of the Service Application, select **Gas Diagnostics**.
2. On the Gas Diagnostics menu, select **Gas Supplies**.
3. Slowly open the cylinder valve for the regulator being tested and observe the pressure reading for the cylinder.
4. **Low Flow Test:**
  - a. On the Gas Diagnostics menu, set the flow of the tested gas to 0.5 l/min.
  - b. On the Gas Diagnostics menu, select **Gas Supplies**.
  - c. Close the cylinder valve and allow the pressure to decay to 2068 kPa (300 psi) as indicated on the cylinder pressure display.
  - d. At the time that the cylinder pressure reaches 2068 kPa (300 psi), select Main Menu on the Gas Diagnostics page to turn off gas flow.
  - e. Within one minute, the test device reading must stabilize between:  
**(60) DIN** 372–400 kPa (54–58 psi)  
**(50) Pin Indexed** 310–341 kPa (45.0–49.5 psi).
    - If the test device pressure does not stabilize within one minute, replace the cylinder supply.
    - If the test device stabilizes within one minute, but the readings are not within specifications, readjust the regulator (Section 5.1.3).

5. **High Flow Test:**

- a. Slowly open the cylinder valve.
- b. Remove the ABS breathing system from the machine to allow continuous Insp Valve flow through the exhalation valve.
- c. On the Main Menu of the Service Application, select **Vent Diagnostics**.
- d. On the Vent Diagnostics page, select **Gas Inlet Vlv ON/OFF** to Open the gas inlet valve.  
Press the ComWheel to return focus to the selection menu.
- e. Select **Flow Valve Control**.

- f. Adjust the Flow Valve counts until the **Flow Valve Setting** at the bottom of the screen reads 65 l/min.
- g. While watching the test device, toggle the Gas Inlet Valve several times (Closed, Open, Closed):
  - Press the ComWheel to return focus to the selection menu.
  - Set Gas Inlet Vlv to Closed.
  - Press the ComWheel to return focus to the selection menu.
  - Set Gas Inlet Vlv to Open.
  - Press the ComWheel to return focus to the selection menu.
  - Set Gas Inlet Vlv to Closed.
  - The minimum test device reading observed must be greater than:  
**(60) DIN 221 kPa (32 psi)**  
**(50) Pin Indexed 207 kPa (30 psi)**
  - Repeat this step (4g) three times.

If the test device reading under “high flow” conditions is less than specified, readjust the regulator per the procedure in Section 5.1.3; however, set the regulated pressure higher by the difference you noted in this step plus 7 kPa (1 psi). This adjusts the “low flow” regulated output to the high side of the specification so that the “high flow” regulated pressure can fall within the specification.

If the regulator subsequently fails the “low flow” specification (step 3d) because the reading is too high, replace the cylinder supply.

6. Set the system switch to Standby.
7. Close the cylinder valve.
8. Bleed the system of all pressure.
9. Disconnect the test device and plug the test port (pull on the plug to ensure it is locked in the fitting).
10. Replace the ABS breathing system.
11. Replace the rear panel.
12. Perform the checkout procedure (Section 3).

**Test B For all gases not used to supply drive gas to the ventilator:**

Under low flow conditions, the output pressure of a properly adjusted/ functioning regulator should fall within specifications listed in step 4e.

Under high flow conditions, the output pressure should not drop below the specifications in step 5b.

1. On the Main Menu of the Service Application, select **Gas Diagnostics**.
2. On the Gas Diagnostics menu, select **Gas Supplies**.
3. Slowly open the cylinder valve for the regulator being tested and observe the pressure reading for the cylinder.
4. **Low Flow Test:**
  - a. On the Gas Diagnostics menu, set the flow of the tested gas to 0.5 l/min.
  - b. On the Gas Diagnostics menu, select **Gas Supplies**.
  - c. Close the cylinder valve and allow the pressure to decay to 2068 kPa (300 psi) as indicated on the cylinder pressure display.
  - d. At the time that the cylinder pressure reaches 2068 kPa (300 psi), select Main Menu on the Gas Diagnostics page to turn off gas flow.
  - e. Within one minute, the test device reading must stabilize between:  
**(60) DIN** 372–400 kPa (54–58 psi)  
**(50) Pin Indexed** 310–341 kPa (45.0–49.5 psi).
    - If the test device pressure does not stabilize within one minute, replace the cylinder supply.
    - If the test device stabilizes within one minute, but the readings are not within specifications, readjust the regulator (Section 5.1.3).

**5. High Flow Test:**

- a. On the Main Menu of the Service Application, select **Gas Diagnostics**.
- b. On the Gas Diagnostics menu, set the flow of the tested gas to 10.0 l/min.

The test device reading must be greater than:

**(60) DIN** 221 kPa (32 psi)

**(50) Pin Indexed** 221 kPa (32 psi)

- If the test device reading under “high flow” conditions is less than specified, readjust the regulator per the procedure in Section 5.1.3; however, set the regulated pressure higher by the difference you noted in this step plus 7 kPa (1 psi). This adjusts the “low flow” regulated output to the high side of the specification so that the “high flow” regulated pressure can fall within the specification.
- If the regulator subsequently fails the “low flow” specification (step 3b) because the reading is too high, replace the cylinder supply.

6. Set the system switch to Standby.
7. Close the cylinder valve.
8. Bleed the system of all pressure.
9. Disconnect the test device and plug the test port (pull on the plug to ensure it is locked in the fitting).
10. Replace the rear panel.
11. Perform the checkout procedure (Section 3).

### 5.1.3 Adjusting Primary Regulators

**Important:** Cylinder supplies in an S/5 Avance machine must have all primary regulators set to the same pressure range:  
(50) Pin Indexed or (60) DIN.

If a regulator is replaced, the replacement regulator must be set (as required) to the same specification as the one removed.

**Important:** Install a full cylinder in the cylinder supply to be adjusted. It is essential that the cylinder be within 10% of its full pressure.

To adjust the primary regulators, follow the procedure in Section 5.1.1 to gain access to the regulators.

Do not attempt to adjust without flow.

1. On the Main Menu of the Service Application, select **Gas Diagnostics**.
2. On the Gas Diagnostics menu, select **Gas Supplies**.
3. Slowly open the cylinder valve for the regulator being tested and observe the pressure reading for the cylinder.
4. On the Gas Diagnostics menu, set the flow of the tested gas to 0.5 l/min.
5. On the Gas Diagnostics menu, select **Gas Supplies**.
6. Close the cylinder valve and allow the pressure to decay to 2068 kPa (300 psi) as indicated on the cylinder pressure display.
7. When the cylinder gauge reaches 2068 kPa (300 psi), adjust the regulator output pressure to:  
**(60) DIN** 386–400 kPa (56–58 psi)  
**(50) Pin Indexed** 327–341 kPa (47.5–49.5 psi).

**Note:** It may be necessary to open the cylinder valve and repeat steps 6 and 7 a number of times to achieve the above setting.

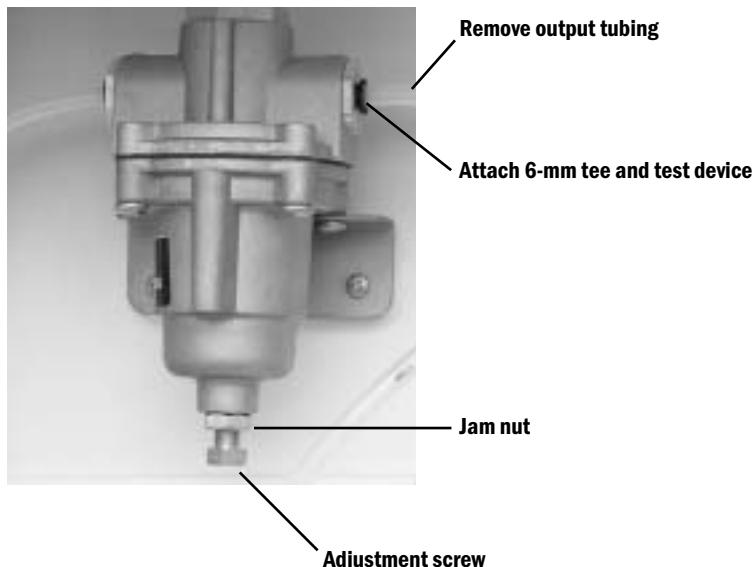
8. Test the regulator settings per the appropriate test in Section 5.1.2:
  - **Test A** — For primary regulators that supply drive gas to the ventilator.
  - **Test B** — For all gases not used to supply drive gas to the ventilator.



Adjust clockwise to increase setting

## 5.2 O<sub>2</sub> Flush Regulator

1. Bleed all gas pressure for the machine (Section 9.1).
2. Remove the upper rear panel (Section 9.2).
3. Remove the O<sub>2</sub> Flush Regulator output tubing. Attach a 6-mm tee and a test device to the open port.



4. Connect an O<sub>2</sub> pipeline supply or slowly open the O<sub>2</sub> cylinder valve.
5. Push the flush button just enough to achieve a slight flow or open the auxiliary flowmeter if equipped with this option. Read the pressure shown on the test device.  
The pressure should be  $241 \pm 7 \text{ kPa}$  ( $35 \pm 1.0 \text{ psi}$ ).
6. If adjustment is required:
  - a. Loosen the adjustment screw's jam nut.
  - b. Adjust the regulator (in small steps) to the above specification.
  - c. Tighten the jam nut.
  - d. Verify the reading.
7. Disconnect the pipeline supply or close the cylinder valve.
8. Bleed gas pressure by pushing the flush button; then, disconnect the tee and test device.
9. Reattach the output tubing to the regulator.
10. Install the rear panel.

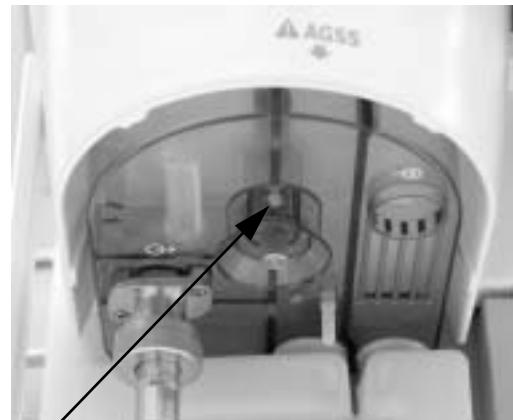
## 5.3 Adjust Drive Gas Regulator

The drive gas regulator must be adjusted while maintaining a flow of 15 l/min. To adjust the flow, you must boot the system with the PCMCIA Service Application and access the Vent Diagnostics function as detailed in Section 8.

The drive gas regulator should provide a constant gas input pressure of 172 kPa (25 psi).

### Calibration setup

1. Attach a pressure test device to the regulator pressure port (shown below)
  - Remove the 6.35-mm (1/4 inch) plug.
  - Attach test device to the open port.
2. Remove the ABS breathing system from the machine to allow continuous Insp Valve flow through the exhalation valve.



Regulator  
pressure  
port

### Calibration procedure:

1. On the Main Menu of the Service Application, select **Vent Diagnostics**.
2. On the Vent Diagnostics page, select **Gas Inlet Vlv ON/OFF** to Open the gas inlet valve.  
Press the ComWheel to return focus to the selection menu.
3. Select **Flow Valve Control**.
4. Adjust the Flow Valve counts until the **Flow Valve Setting** at the bottom of the screen reads 15 l/min.
5. If required, adjusting the regulator to  $172 \pm 1.72$  kPa ( $25 \pm 0.25$  psi).

## 5.4 Ventilator Calibrations

Before performing the ventilator calibrations, verify that the drive gas regulator is adjusted to specifications (Section 5.3).

The Service menu structure is detailed in Section 4. To access the Ventilator Calibrations menu:

1. Turn on the system.
2. Navigate the menu selections to the **Installation** menu.
  - On the **Checkout** menu, select **Bypass Checks**.
  - On the **Start Case** menu, press the **Main Menu** button.
  - On the **Main Menu**, select **Screen Setup**.
  - On the **Screen Setup** menu, select **Install/Service** (dial in 16 - 4 - 34).
  - On the **Install/Service** menu, select **Service** (dial in 26 - 23 - 8).
  - On the **Service** menu, select **Calibration**.

Unless otherwise specified, perform the ventilator calibrations in the order that they appear on the Calibration menu.

- User Calibration
- Manifold P Span
- Insp Flow Zero
- Insp Flow Valve
- Bleed Resistor
- Paw Span

The following calibrations should be performed as required:

- Zero Gas Xducer:
  - The pipeline and cylinder pressure transducer should be “zeroed” at least once a year.
  - Whenever a pipeline or cylinder pressure transducer is replaced.
- Cal Config:
  - Reset the **Ventilator Drive Gas** to match the machine configuration.
  - Reset the **Altitude** whenever the machine is moved to a new location that differs by more than 100 meters.

### 5.4.1 Cal Config

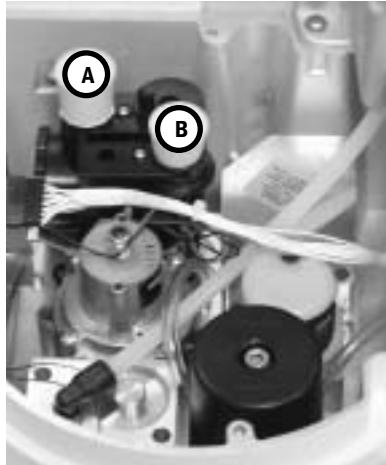
Before calibration, you must verify that the Ventilator Drive Gas and the Altitude settings are set appropriately to match the current drive gas configuration and machine location.

If you change any of the settings in the Cal Config menu, you must restart the system.

3. On the **Installation** menu, select **Configuration**.
4. On the **Configuration** menu, verify the **Ventilator Drive Gas** and the **Altitude** setting; adjust as necessary.
5. When done, reboot the system (System switch to Standby; then On).

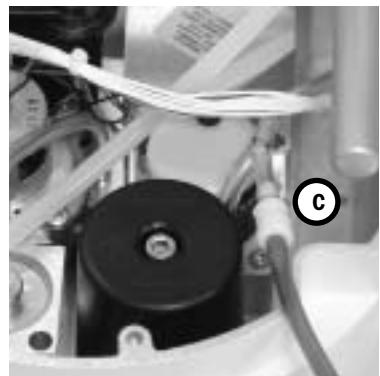
## 5.4.2 Manifold P Span

### Calibration setup:



1. Remove the ABS breathing system from the machine.
2. Remove the Exhalation Valve.
3. Remove the Vent Engine cover.
4. Plug the Drive Port (**A**) and the Manifold Port (**B**) on the Vent Engine interface valve.
5. Connect the manifold pressure tee adapter (**C**) – refer to Section 10.1.2 – to the Manifold Pressure Transducer tubing (white inline connectors).
6. Connect a manometer to the open port of the tee adapter.

### Calibration procedure:



1. On the Calibration menu, select **Manifold P Span**.
2. Select **Start Manifold P Span**.
3. Adjust the Insp Flow Valve (DAC) setting until the manometer reading equals 100 cmH<sub>2</sub>O:
  - start at approximately 950 counts (press the ComWheel to activate).
  - continue to increment the count until the manometer reading equals 100 cmH<sub>2</sub>O.
4. Select **Save Calibration**.
5. Select **Previous Menu**.
6. Disconnect the manometer from the tee adapter.
7. Remove the tee adapter and reconnect the Manifold Pressure Transducer tubing.

## 5.4.3 Insp Flow Zero

### Calibration setup

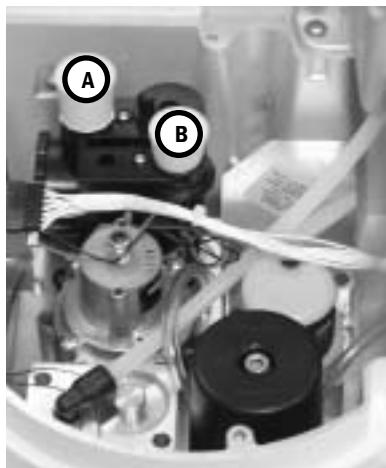
Leave the Drive Port (**A**) and the Manifold Port (**B**) on the interface valve plugged.

### Calibration procedure:

1. On the Calibration menu, select **Insp Flow Zero**.
2. Select **Start**.
3. Select **Previous Menu**.

## 5.4.4 Inspiratory Flow Valve Cal

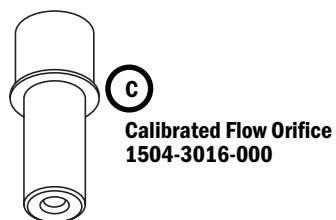
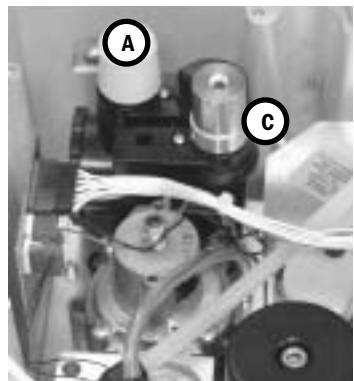
### Calibration setup



Leave the Drive Port (**A**) and the Manifold Port (**B**) on the interface valve plugged.

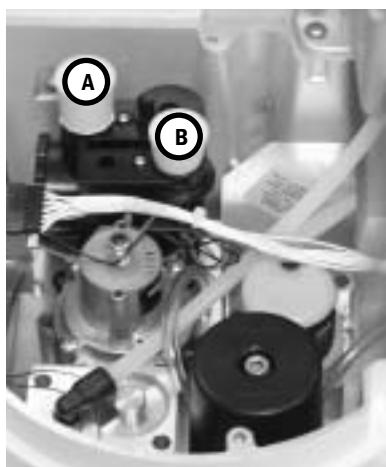
### Calibration procedure:

1. On the Calibration menu, select **Insp Flow Valve**.
2. Push the ComWheel to enable the **Stage 1** calibration.
3. When Stage 1 is completed, remove the plug from the Manifold port and insert the calibrated orifice (**C**)
4. Push the ComWheel to enable the **Stage 2** calibration.  
(May take two minutes before you see any effects of the test on the screen.)
5. When Stage 2 is completed, select **Previous Menu**.



## 5.4.5 Bleed Resistor Cal

### Calibration setup



1. Remove the Calibration Orifice from the Manifold port.
2. Plug the Manifold (**B**) port.
3. Leave the Drive Gas (**A**) port plugged.

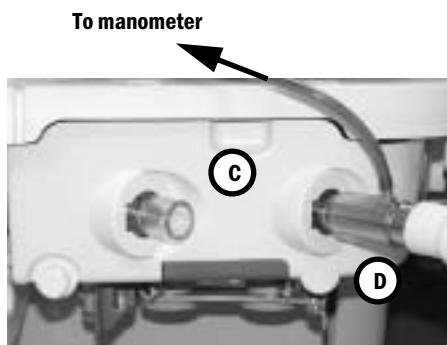
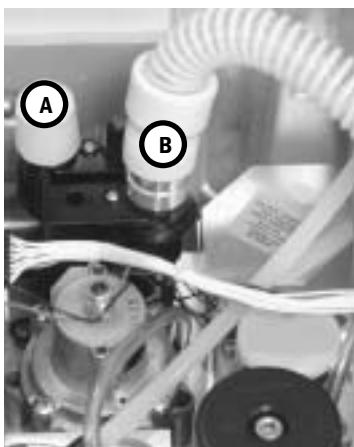
### Calibration procedure

1. On the Calibration menu, select **Bleed Resistor**.
2. Select **Start**.
3. When the test is completed, select **Previous Menu**.

## 5.4.6 Paw Span

### Calibration setup

1. Leave the Drive port (**A**) port plugged.
2. Remove the plug from the Manifold port.
3. Attach a patient circuit tube to the Calibrated Flow Orifice.
4. Insert the Calibrated Flow Orifice into the Manifold port (**B**).
5. Separate the Circuit module from the ABS Bellows module.
6. Install only the Circuit module (**C**) on to the machine.
7. Connect a pressure sensing tee (**D**) to the inspiratory flow patient connection.
8. Connect the open end of the patient circuit tube to the flow port of the pressure sensing tee.
9. Connect a manometer to the pressure sensing port of the tee connector.



### Calibration procedure

1. On the Calibration menu, select **Paw Span**.
2. Select **Start Paw Span**.
3. Adjust the Insp Flow Valve (DAC) setting until the manometer reading equals 100 cmH<sub>2</sub>O:
  - start at approximately 950 counts (press the ComWheel to activate).
  - continue to increment the count until the manometer reading equals 100 cmH<sub>2</sub>O.
4. Select **Save Calibration**.
5. Select **Previous Menu**.

# 6 Maintenance

## In this section

This section covers the regular maintenance procedures (minimum requirements) needed to make sure that the S/5 Avance anesthesia machine operates to specifications.

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## ⚠️ WARNINGS

Do not perform testing or maintenance on the S/5 Avance anesthesia machine while it is being used on a patient. Possible injury can result.

Items can be contaminated due to infectious patients. Wear sterile rubber gloves. Contamination can spread to you and others.

Obey infection control and safety procedures. Used equipment may contain blood and body fluids.

## 6.1 S/5 Avance Planned Maintenance

Serial Number:	Date: (YY/MM/DD)	/ /
Hospital:	Performed by:	
<input type="checkbox"/> 12 months <input type="checkbox"/> 24 month <input type="checkbox"/> 48 month <input type="checkbox"/> _____		

### 6.1.1 Every twelve (12) months

Perform the following steps every 12 months.

For details, refer to the sections listed.

- Sections marked URM are found in the User's Reference manuals for the Avance anesthesia system.
- Sections marked TRM are found in this Technical Reference manual.

#### Parts Replacement

- Replace the vaporizer port o-rings (*TRM - Section 9.12.1*)  
(Kit Stock Number 1102-3016-000)

#### Checks and Tests

- 1. AGSS Maintenance (*URM - Part 2, Section 2*):
  - Empty any condensate from the reservoir (disposable item).
  - Inspect air brake for occlusion on active AGSS.
  - Inspect, clean or replace filter on active AGSS.
- 2. Breathing System Maintenance (*URM - Part 2, Section 2*)
- 3. Bellows Assembly Maintenance (*URM - Part 2, Section 2*)
- 4. Bellows Assembly Tests (*URM - Part 2, Section 2*)
- 5. O<sub>2</sub> Cell Calibration (*URM - Part 2, Section 3*)
- 6. Flow Sensors Calibration (*URM - Part 1, Section 5*)
- 7. Perform the checkout procedures in Section 3.
  - Inspect the system (*TRM - Section 3.1*)
  - Backlight test (*TRM - Section 3.3*)
  - Vaporizer back pressure test (*TRM - Section 3.4*)
  - Pipeline and cylinder tests (*TRM - Section 3.5*)
  - O<sub>2</sub> supply alarm test (*TRM - Section 3.5.1*)
  - Pressure relief tests (*TRM - Section 3.6*)
  - Flush Flow Test (*TRM - Section 3.7*)
  - Alarm tests (*TRM - Section 3.8*)
  - Power failure test (*TRM - Section 3.12*)
- 8. Alternate O<sub>2</sub> flowmeter tests (*TRM - Section 6.6*)
- 9. Auxiliary O<sub>2</sub> flowmeter tests (*TRM - Section 6.7*)
- 10. Integrated Suction Regulator tests (*TRM - Section 6.8*)
- 11. Mixer outlet check valve leak test (*TRM - Section 6.5.1*)

- 12. Mixer flow verification test (*TRM - Section 6.5.2*)
- 13. Perform the following diagnostics using the PCMCIA Service Application.
  - Display Diagnostics (*TRM - Section 8.4*).
  - MOPV pressure relief valve test (*TRM - Section 6.3*).
  - Pressure Limit Circuit test (*TRM - Section 6.4*).
  - Adjust Drive Gas Regulator (*TRM - Section 5.3*).
- 14. From the Service Calibration menu (*TRM - Section 4.4.3*), perform the following (refer to *TRM - Section 5.4* for details):
  - User Cals
  - Manifold P Span
  - Inspiratory flow zero
  - Inspiratory flow valve
  - Bleed resistor
  - Paw Span
  - Zero Gas Transducers
- 15. From the Service Log menu (*TRM - Section 4.4.2*), perform the following:
  - Access the Error History log. If any error codes have been logged, follow the appropriate troubleshooting procedures. Clear the error log.
- 16. Perform the system “All Checks” (*TRM - Section 3.2*).
  - Low P leak check (*TRM - Section 3.2.1*)
  - Quick check (*TRM - Section 3.2.2*)
  - Vent check (*TRM - Section 3.2.3*)
  - Circuit O<sub>2</sub> cell check (*TRM - Section 3.2.4*)
- 17. Electrical safety tests (*TRM - Section 3.13*).

### 6.1.2 Every twenty-four (24) months

In addition to the 12-month requirements, replace the following parts every 24 months. All parts should be replaced before performing the checks, tests, and calibrations.

#### Parts Replacement

**Refer to** *TRM - Section 6.2*.

Perform the following step:

- 1. Replace the free breathing flapper valve (Stock Number 0211-1454-100).
- 2. Replace the free breathing valve o-ring (Stock Number 1503-3208-000).

### 6.1.3 Every forty-eight (48) months

In addition to the 24-month requirements, replace the following parts every 48 months. All parts should be replaced before performing the checks, tests, and calibrations.

#### Parts Replacement

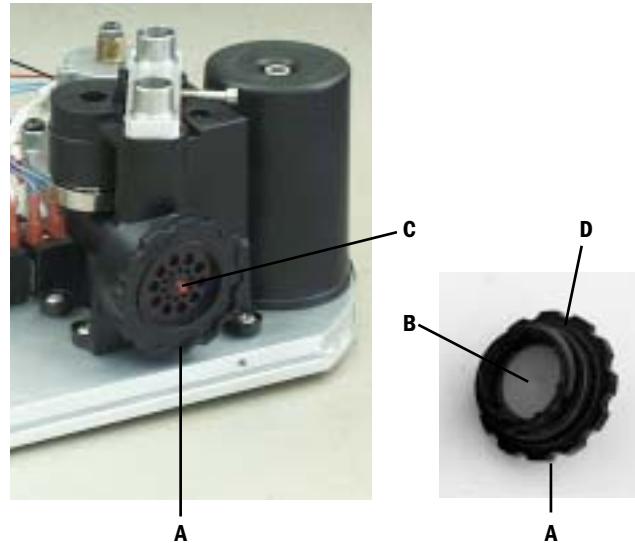
**Refer to** *TRM - Section 9.6.3*.

Perform the following step:

- 1. Replace the system batteries\* (Stock Number 1009-5682-000).

**\*Note:** Refer to the “Battery capacity test” in *TRM - Section 6.9*.

## 6.2 Free breathing valve maintenance



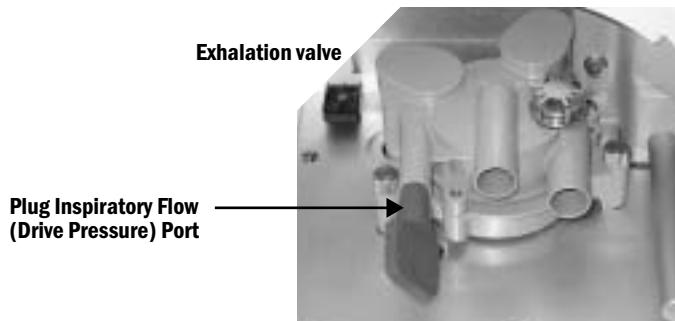
1. Unscrew the valve seat (**A**) from the side of the interface manifold.
2. Inspect the flapper (**B**) and valve seat for nicks, debris and cleanliness.
3. If necessary, clean the new flapper valve with alcohol.
4. Pull the tail (**C**) of the new free breathing valve flapper through the center of the valve seat until it locks in place.
5. Trim the tail flush with outside surface of the valve seat (refer to the removed flapper).
6. Replace the O-ring (**D**). Lubricate with a thin film of Krytox.
7. Hand screw the assembly into the interface manifold.
8. Reassemble the system.
9. Perform the Preoperative Checkout Procedure (refer to the User's Reference manual).

## 6.3 MOPV pressure relief valve test

- ⚠️ WARNING** Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:
- Do not use a test plug that is small enough to fall into the breathing system.
  - Make sure that there are no test plugs or other objects caught in the breathing system.

### 6.3.1 Test setup

1. Remove the ABS breathing system.
2. Plug the inspiratory flow (drive pressure) port of the exhalation valve with a stopper.



### 6.3.2 Test procedure

To test the pressure relief valve, you must establish a flow (blocked by setup above) of 30 l/min through the Inspiratory Flow Control valve. To adjust the flow, you must boot the system with the PCMCIA Service Application and access the Vent Diagnostics function as detailed in Section 8.

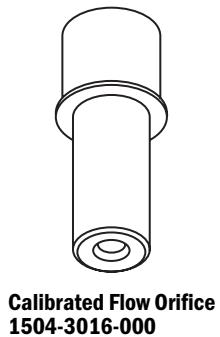
1. On the Main Menu of the Service Application, select **Vent Diagnostics**.
2. On the Vent Diagnostics page, select **Gas Inlet Vlv ON/OFF** to Open the gas inlet valve.  
Press the ComWheel to return focus to the selection menu.
3. Select **Flow Valve Control**.
4. Adjust the Flow Valve counts until the **Flow Valve Setting** at the bottom of the screen reads approximately 30 l/min.
5. Carefully listen for the MOPV relief weight to be relieving and “popping off” from its seat (a purring sound). This indicates the valve is functioning correctly.
6. Set the system switch to Standby.
7. Remove the stopper from the inspiratory flow port.
8. Reassemble the system.
9. Perform the Preoperative Checkout Procedure (refer to the User’s Reference manual).

## 6.4 Pressure Limit Circuit test

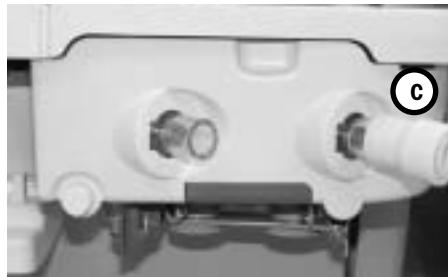
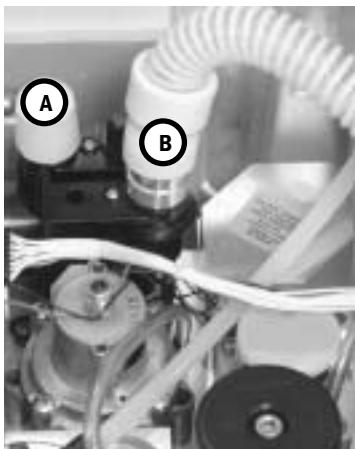
To perform the test:

- establish a closed patient airway circuit.
- increment the pressure in the airway circuit.
- observe the output of the airway pressure transducer.
- note that the “pressure limit circuit” trips at approximately 109 cmH<sub>2</sub>O.

### Test setup



1. Remove the ABS breathing system from the machine.
2. Remove the Exhalation Valve.
3. Remove the Vent Engine cover.
4. Separate the Circuit Module from the ABS Bellows Module.
5. Install the Circuit Module only.
6. Plug the Drive Port (**A**) on the Vent Engine interface valve.
7. Attach a patient circuit tube to the Calibrated Flow Orifice test tool.
8. Insert the Calibrated Flow Orifice into the Manifold (pilot) Port (**B**).
9. Connect the open end of the patient circuit tube to the inspiratory flow patient connection (**C**).



**Test Procedure**

1. On the Main Menu of the Service Application, select **Vent Diagnostics**.
2. On the Vent Diagnostics menu, select **Status** and verify that “Over Pressure Circuit” reads OK.
3. Press the ComWheel to return focus to the selection menu.
4. Select **Gas Inlet Vlv ON/OFF** to Open the gas inlet valve.  
Press the ComWheel to return focus to the selection menu.
5. Select **Flow Valve Control**.
6. Adjust the Flow Valve counts to approximately 1000 counts and observe the “Airway Pressure” reading.
7. Increase the flow count slowly until the “Airway Pressure” reading reaches approximately 109 cmH<sub>2</sub>O.
8. Continue to increase the flow by one encoder click and observe the airway pressure until gas flow stops.
9. Select the Status page and verify that:
  - “Over Pressure Circuit” reads High Pressure.
  - “Gas Inlet Valve Feedback” reads Closed.
8. Reassemble the system.
9. Perform the Preoperative Checkout Procedure  
(refer to the User’s Reference manual).

## 6.5 Mixer test

To perform the mixer tests, you must gain access to the mixer outlet tubing which is connected to the inlet of the vaporizer manifold.

1. Remove the rear cover.
2. Disconnect the mixer outlet tube at the inlet to the vaporizer manifold.

### 6.5.1 Mixer outlet check valve leak test

To test the mixer outlet check valve you must apply back pressure to the check valve through the mixer outlet tubing and time the leak down rate of the pressure.

1. Tee in a pressure gauge and a syringe to the mixer outlet tube.
2. Slowly pressurize the mixer outlet check valve to 200 mmHg.
3. The pressure shown on the test gauge should not decrease by more than 10 mmHg in 30 seconds.

### 6.5.2 Mixer flow verification

To perform the flow verification test, you must attach a flowmeter to the mixer outlet tubing and access the Gas Diagnostics function on the PCMCIA Service Application (*TRM - Section 8.2*).

1. Connect a flowmeter to mixer outlet tubing.
2. On the Gas Diagnostics menu, select the following and verify the readings on the test flowmeter.

Verify Flowmeter Reading		
Select	Lower Limit l/min	Upper Limit l/min
100% O <sub>2</sub> at 10 l/min	9.0	11.0
100% O <sub>2</sub> at 0.5 l/min	0.45	0.55
Air at 10 l/min	9.0	11.0
Air at 0.5 l/min	0.45	0.55
100% N <sub>2</sub> O at 10 l/min	9.0	11.0
100% N <sub>2</sub> O at 0.5 l/min	0.45	0.55

#### Note

If you will be testing the Auxiliary O<sub>2</sub> flowmeter (*TRM - Section 6.6*), you can proceed to the Alternate O<sub>2</sub> "Flow Accuracy Test" at this point without reassembling the machine.

3. Remove the test device.
4. Connect the mixer outlet tubing to the vaporizer manifold
5. Replace the back cover.
10. Perform the Preoperative Checkout Procedure  
(refer to the User's Reference manual).

## 6.6 Alternate O<sub>2</sub> flowmeter tests

1. Open the O<sub>2</sub> cylinder valve or connect an O<sub>2</sub> pipeline.
2. Rotate the Alt O<sub>2</sub> flow control fully clockwise to minimum flow.
3. Press the Alternate O<sub>2</sub> switch to turn on Alternate O<sub>2</sub> flow.  
The flowmeter should indicate 0.5 to 0.7 L/min.
4. Rotate the flow control counterclockwise (increase). The ball should rise immediately after rotation is begun. It should rise smoothly and steadily with continued counterclockwise rotation. When a desired flow is set, the ball should maintain in a steady position.
5. Rotate the flow control clockwise to minimum flow.
6. Press the Alternate O<sub>2</sub> switch to turn off Alternate O<sub>2</sub> flow; confirm yes.

### Flow Accuracy Test

**Note:** To check flow accuracy, be sure that the flow test device is capable of measuring 0–15 l/min with an accuracy of  $\pm 2\%$  of reading.

To perform the mixer tests, you must gain access to the mixer outlet tubing which is connected to the inlet of the vaporizer manifold.

1. Remove the rear cover.
2. Disconnect the mixer outlet tube at the inlet to the vaporizer manifold.
3. Connect a flowmeter to mixer outlet tubing.
4. Adjust the flowmeter so the **center** of the ball aligns with the selected test point (observe that the ball maintains a steady position for 10 seconds).
5. The test device reading should be between the limits shown for each of the selected settings in the table below.

**Flow Tester Reading**

<b>Flowmeter Setting L/min</b>	<b>Lower Limit l/min</b>	<b>Upper Limit l/min</b>
minimum (valve fully closed)	0.50	0.70
1	0.52	1.48
3	2.56	3.44
5	4.60	5.40
10	9.70	10.30
maximum (valve fully open)	10.00	13.00

6. Rotate the flow control clockwise to minimum flow.
7. Close the O<sub>2</sub> cylinder valve or disconnect the O<sub>2</sub> pipeline.
8. Remove the test device.
9. Connect the mixer outlet tubing to the vaporizer manifold
10. Replace the back cover.
11. Perform the Preoperative Checkout Procedure  
(refer to the User's Reference manual).

## 6.7 Auxiliary O<sub>2</sub> flowmeter tests

1. Open the O<sub>2</sub> cylinder valve or connect an O<sub>2</sub> pipeline.
2. Rotate the flow control clockwise (decrease) to shut off the flow. The ball should rest at the bottom of the flow tube and not move.
3. Rotate the flow control counterclockwise (increase). The ball should rise immediately after rotation is begun. It should rise smoothly and steadily with continued counterclockwise rotation. When a desired flow is set, the ball should maintain in a steady position.
4. Rotate the flow control clockwise to shut off the flow.

### Flow Accuracy Test

**Note:** To check flow accuracy, be sure that the flow test device is capable of measuring 0 to 15 L/min with an accuracy of  $\pm 2\%$  of reading.

1. Connect the flowmeter outlet to the flow test device.
2. Adjust the flowmeter so the **center** of the ball aligns with the selected test point (observe that the ball maintains a steady position for 10 seconds).
3. The test device reading should be between the limits shown for each of the selected settings in the table below.

Flow Tester Reading		
Flowmeter Setting L/min	Lower Limit L/min	Upper Limit L/min
1	0.52	1.48
3	2.56	3.44
5	4.60	5.40
10	9.70	10.30
maximum (valve fully open)	12.00	-----

4. Rotate the flow control clockwise to shut off the flow.
5. Close the O<sub>2</sub> cylinder valve or disconnect the O<sub>2</sub> pipeline.

## 6.8 Integrated Suction Regulator tests

**Note** There are two types of integrated suction systems for the Avance anesthesia machine:

- Continuous Vacuum Regulator, Three-Mode, Pipeline Vacuum
- Continuous Vacuum Regulator, Three-Mode, Venturi Derived Vacuum

**For Pipeline Vacuum systems,**

a vacuum source of at least 500 mm Hg (67 kPa or 20 in Hg) is required for testing. The supply open flow must be a minimum of 50 L/min.

**For Venturi Derived Vacuum systems,**

an O<sub>2</sub> or Air source of at least 282 kPa (41 psi) is required for testing.

**Gauge Accuracy** The gauge needle should come to rest within the zero range bracket when no suction is being supplied. Gauges which do not comply may be out of tolerance.

**Note** To check gauge accuracy, be sure that the test gauge is capable of measuring 0 to 550 mm Hg with an accuracy of  $\pm 1\%$  of reading.

1. Connect the suction patient port to the test gauge.
2. Turn the mode selector switch to I (ON).
3. Ensure that the vacuum test gauge is in agreement with the suction vacuum gauge  $\pm 38$  mm Hg/5 kPa at the following test points.

**Test points**

<b>Suction vacuum gauge</b>	<b>Test gauge tolerance</b>
100 mm Hg (13.3 kPa)	62–138 mm Hg (8.3–18.4 kPa)
300 mm Hg (40 kPa)	262–338 mm Hg (35–45 kPa)
500 mm Hg (66.7 kPa)	462–538 mm Hg (61.6–71.7) kPa

**Flow Test** **Note:** To check flow accuracy, be sure that the flow test device is capable of measuring 0–30 L/min.

1. Connect the patient port of the suction regulator to the flow test device.
2. Rotate the suction control knob fully clockwise (increase).
3. Turn the mode selector switch to I (ON) and verify that the flow rate is:
  - at least 20 L/min.
4. Disconnect the test flowmeter.

**(Tests continue on next page.)**

- Regulation Test**
1. Turn the mode selector switch to I (ON).
  2. Occlude the patient port of the suction regulator.
  3. Set the vacuum regulator gauge to 100 mm Hg/13 kPa.
  4. Open and close the patient port several times.
  5. With the patient port occluded, the gauge should return to 100 mm Hg/13 kPa within a tolerance of  $\pm$  10 mm Hg/1.3 kPa.
- Vacuum Bleed Test**
1. Occlude the patient port of the suction regulator.
  2. Set the vacuum regulator gauge to 100 mm Hg/13 kPa.
  3. Turn the mode selector switch to O (OFF) and observe the gauge needle. It must return to the zero range bracket or stop pin within 10 seconds.
- Vacuum Leak Test**
1. Turn the mode selector switch to O (OFF).
  2. Rotate the suction control knob a minimum of two full turns in the clockwise direction (increase suction) to ensure its setting is not at the off position.
  3. Occlude the patient port of the suction regulator.
  4. Observe the suction gauge, the needle should not move.
  5. Rotate the suction control knob fully counterclockwise to ensure its setting is at the fully off position.
  6. Turn the mode selector switch to I (ON).
  7. Observe the suction gauge, the needle should not move.

## 6.9 Battery capacity test

Although replacement of the backup batteries is recommended at the end of 4 years, batteries that pass the capacity test can be considered viable for battery backup of the system for up to 6 years at the discretion of the hospital.

Before testing the batteries, ensure that they are fully charged.

### Test procedure

1. Turn the system on and start a case (simulated).
2. Turn off the mains system breaker on the AC Inlet.
3. Allow the system to run on battery until it does an orderly shutdown and powers off (can be in excess of 90 minutes).
4. Set the system switch to Standby and turn on the mains system breaker.
5. Boot the system with the PCMCIA Service Application and access the Power Diagnostics function as detailed in Section 8.
  - On the Main Menu of the Service Application, select **Power Diagnostics**.
  - On the Power Diagnostic menu, select **Power Controller**.
6. Page 1 of the Power Control Power Diagnostics screen shows the “Date battery Tested” (the last full battery discharge) and the “Discharge Time”.
  - If the “Discharge Time” is greater than 45 minutes, the batteries can be left in service for one more year.
  - If the “Discharge Time” is less than 45 minutes, both batteries should be replaced.

## Notes

# 7 Troubleshooting

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## 7.1 General Troubleshooting

**⚠ WARNING** Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

Problem	Possible Cause	Action
High Pressure Leak	Pipeline leak	Use a leak detector or Snoop to check for source of leak. Repair or replace defective parts.
	O <sub>2</sub> flush valve	Use a leak detector or Snoop to check for source of leak. Make sure tubing connections are tight. Replace valve if defective.
	System switch	Use a leak detector or Snoop to check for source of leak. Make sure tubing connections are tight. Replace switch if defective.
	Cylinder not installed properly	Make sure cylinder is correctly aligned. Verify that tee handles are tight.
	Cylinder transducer	Use a leak detector or Snoop to check for source of leak. Tighten/replace transducer if defective.
	Cylinder gaskets	Use a leak detector or Snoop to check for source of leak. Replace gasket if defective.
	Relief valves	Use a leak detector or Snoop to check for source of leak. Replace valve if defective.
Low Pressure Leak (with vaporizer mounted)	Vaporizer not installed properly	Reseat vaporizer if not installed properly. Have vaporizer serviced at vaporizer center if vaporizer leaks.
	Missing or damaged o-ring on vaporizer manifold	Check condition of o-ring. Replace if missing or damaged.
	Loose fill port	Check fill port. Tighten if loose.

<b>Problem</b>	<b>Possible Cause</b>	<b>Action</b>
Low Pressure Leak (with or without vaporizer)	Leaking port valve on vaporizer manifold	Use the Vaporizer Manifold Valve Tester to check for leak. See Section 9.12.2 for instructions. If test fails, tighten, repair, or replace as needed.
	Leak in mixer	If vaporizer manifold passed previous tests: Remove tubing from inlet port of vaporizer manifold (mixer outlet tube) and perform leak test of mixer.
	Leaking relief valve on vaporizer manifold	Remove relief valve. Occlude opening. Perform leak test. If test passes, replace valve.
	Leaking flush valve	Attach pressure measuring device on CGO. Replace valve if device shows increased pressure.
Bellows leak	Leaking system switch	Attach pressure measuring device on CGO. Replace switch if device shows increased pressure.
	Pop-off valve diaphragm not sealing properly	Disassemble pop-off valve; inspect and clean seats; reseat; reassemble.
	Bellows mounting rim loose	Remove rim and pop-off valve diaphragm; reseat diaphragm; snap rim (2) into place.
Breathing System Leak	Bellows improperly mounted or has a hole or tear	Check that only the last bellows convolute is mounted to the rim and that the ring roll is in the groove under the rim. Inspect the bellows for damage; replace.
	Absorber canister open or missing	Install canister properly.
	Soda lime dust on canister seals	Clean seals and mating surfaces.
Breathing System Leak (Intermittent)	ACGO O <sub>2</sub> sense check valve	Replace.
Unable to begin mechanical ventilation	ABS not fully engaged	Remount ABS.
	No O <sub>2</sub> supply	Check O <sub>2</sub> supply.
	Defective Bag/Vent switch	Check Bag/Vent switch.

## 7.2 Breathing System Leak Test Guide

- Note** Always do the **System “All Checks”** (Section 3.2) on the machine before proceeding with these breathing system leak tests.
- The **Low P leak check** looks for leaks between the mixer, vaporizer, and the inspiratory side of the breathing circuit.
  - A failure in **Quick check** indicates a leak in Bag Mode.
  - A failure in **Vent check** indicates a leak in Vent Mode.
- Follow the troubleshooting flowcharts in Section 7.2.2 to determine the best sequence of tests for locating a breathing system leak.
- The procedures in Section 7.2.3 test specific components of the breathing system for leaks.

- ⚠ WARNING** Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:
- Do not use a test plug that is small enough to fall into the breathing system.
  - Make sure that there are no test plugs or other objects caught in the breathing system.

## 7.2.1 Check Valves

Make sure that the check valves on the breathing circuit module work correctly: The Inspiratory check valve rises during inspiration and falls at the start of expiration. The Expiratory check valve rises during expiration and falls at the start of inspiration. A leak across one of the check valves may be great enough to cause a “reverse flow” alarm.

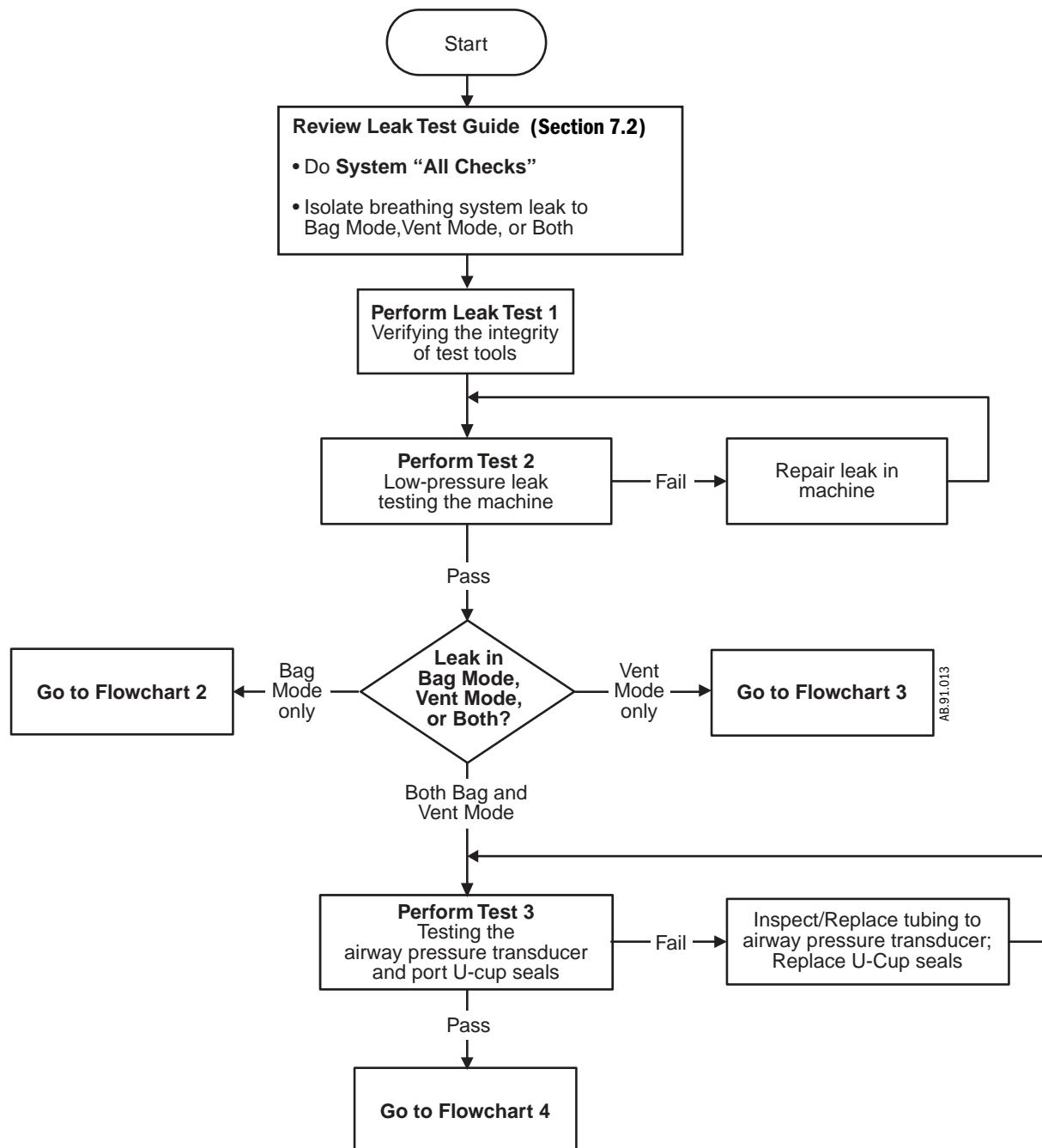
### Inspiratory check valve

1. Set the system switch to On.
2. Set fresh gas flow to minimum.
3. If equipped with an ACGO, connect a tube between the ACGO outlet and the Inspiratory port.
  - Set the ACGO switch to the ACGO position.
  - Verify that the Airway Pressure reading increases to 10 cm H<sub>2</sub>O in 30 seconds.
4. If not equipped with an ACGO, select End Case and connect a tube to the Inspiratory port.
  - Stretch the tube approximately 5 cm.
  - Occlude the open end of the tube.
  - Release the tension on the tube.
  - Ensure that the Airway Pressure reading increases to between 20 and 40 cm H<sub>2</sub>O. If not, repeat the above steps, but stretch the tube a little further.
  - Verify that the Airway Pressure reading does not drop by more than 10 cm H<sub>2</sub>O in 30 seconds.

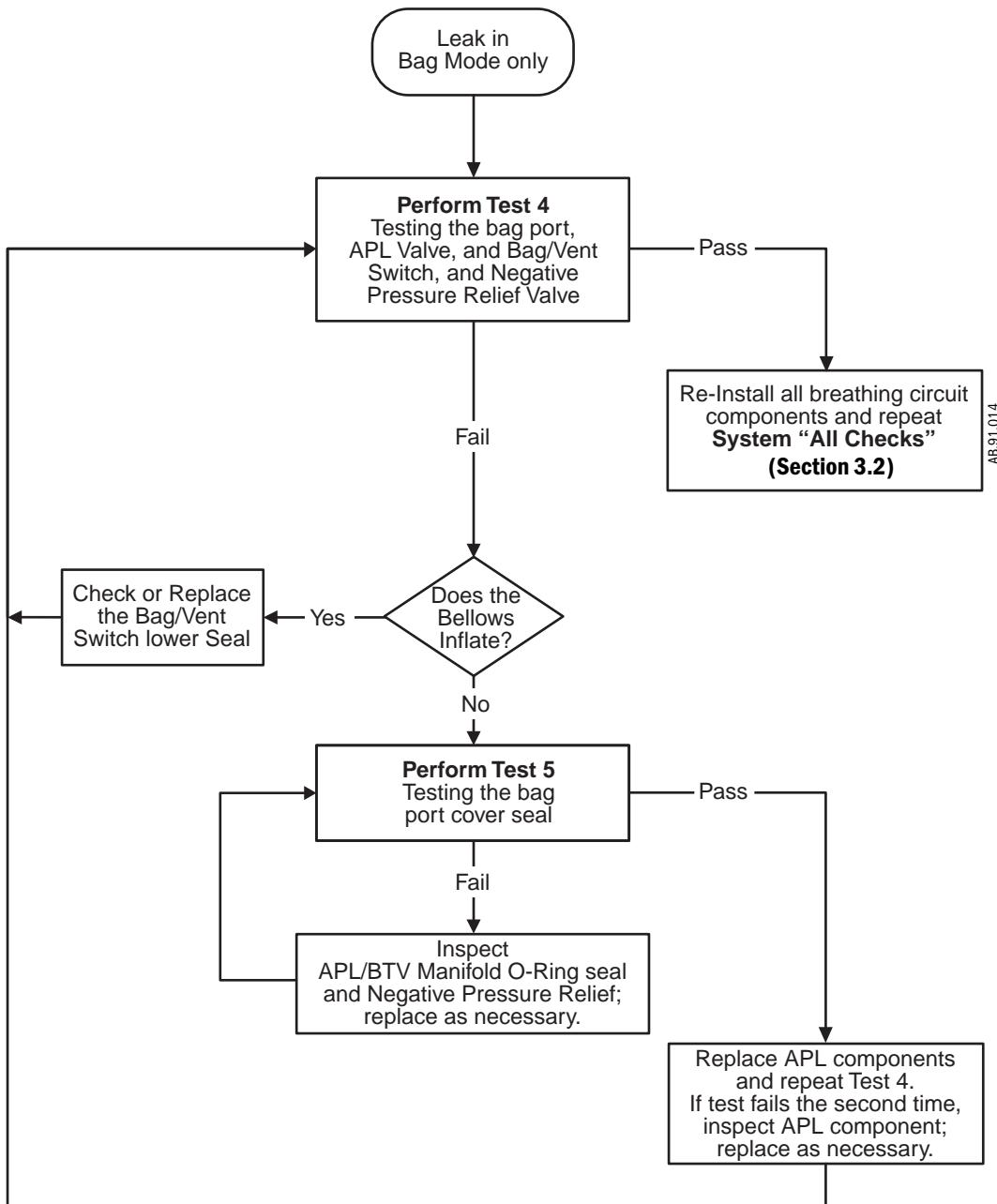
### Expiratory check valve

1. Set all gas flows to minimum.
2. Set the Bag/Vent switch to Bag.
3. Fully close the APL valve (70 cm H<sub>2</sub>O).
4. Connect a tube between the Inspiratory port and the Bag port.
5. Slowly increase the O<sub>2</sub> flow to achieve 30 cm H<sub>2</sub>O.
  - The leak rate is equal to the flow needed to maintain 30 cm H<sub>2</sub>O.
  - The leak rate should be less than 500 mL/min.

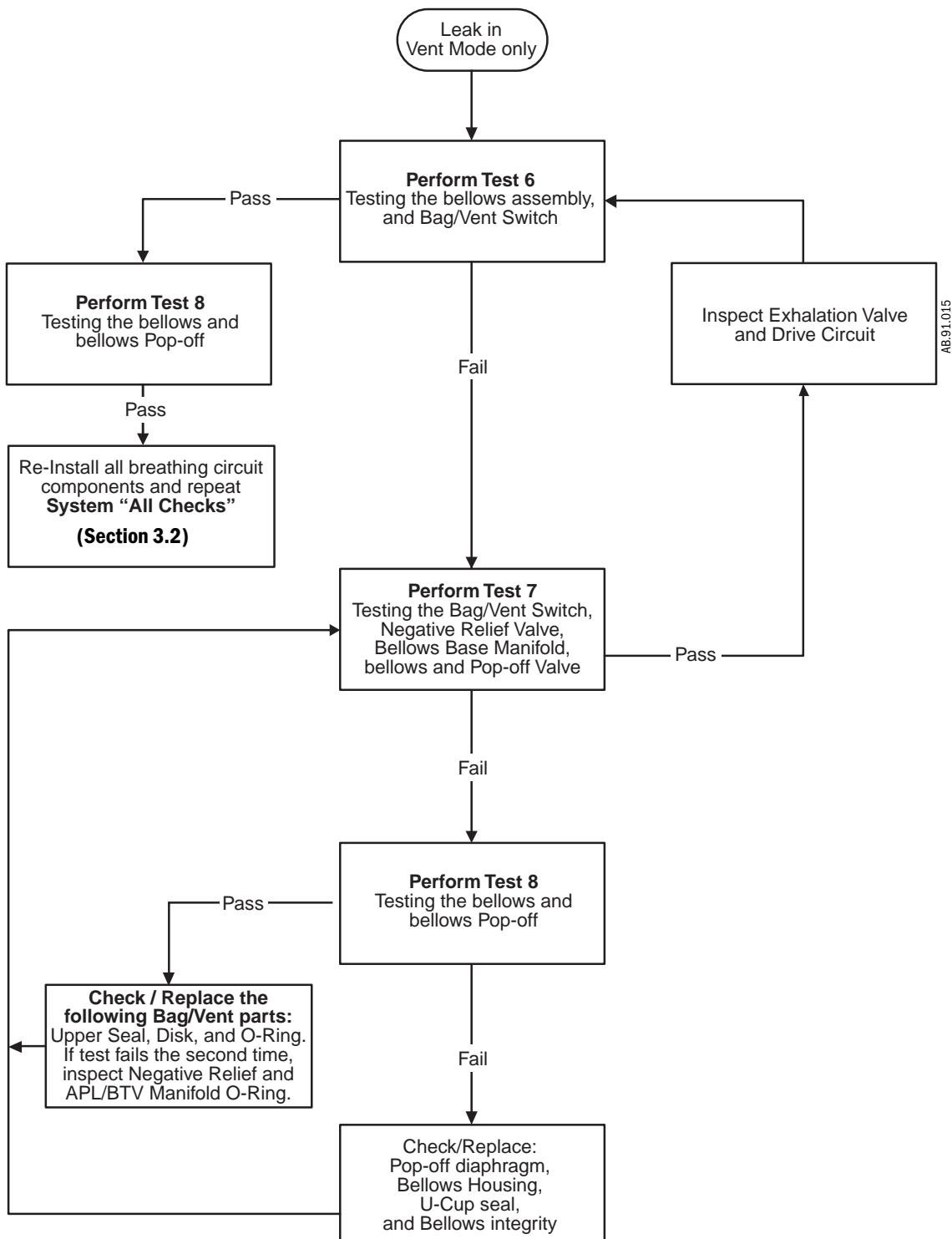
## 7.2.2 Breathing System Troubleshooting Flowcharts



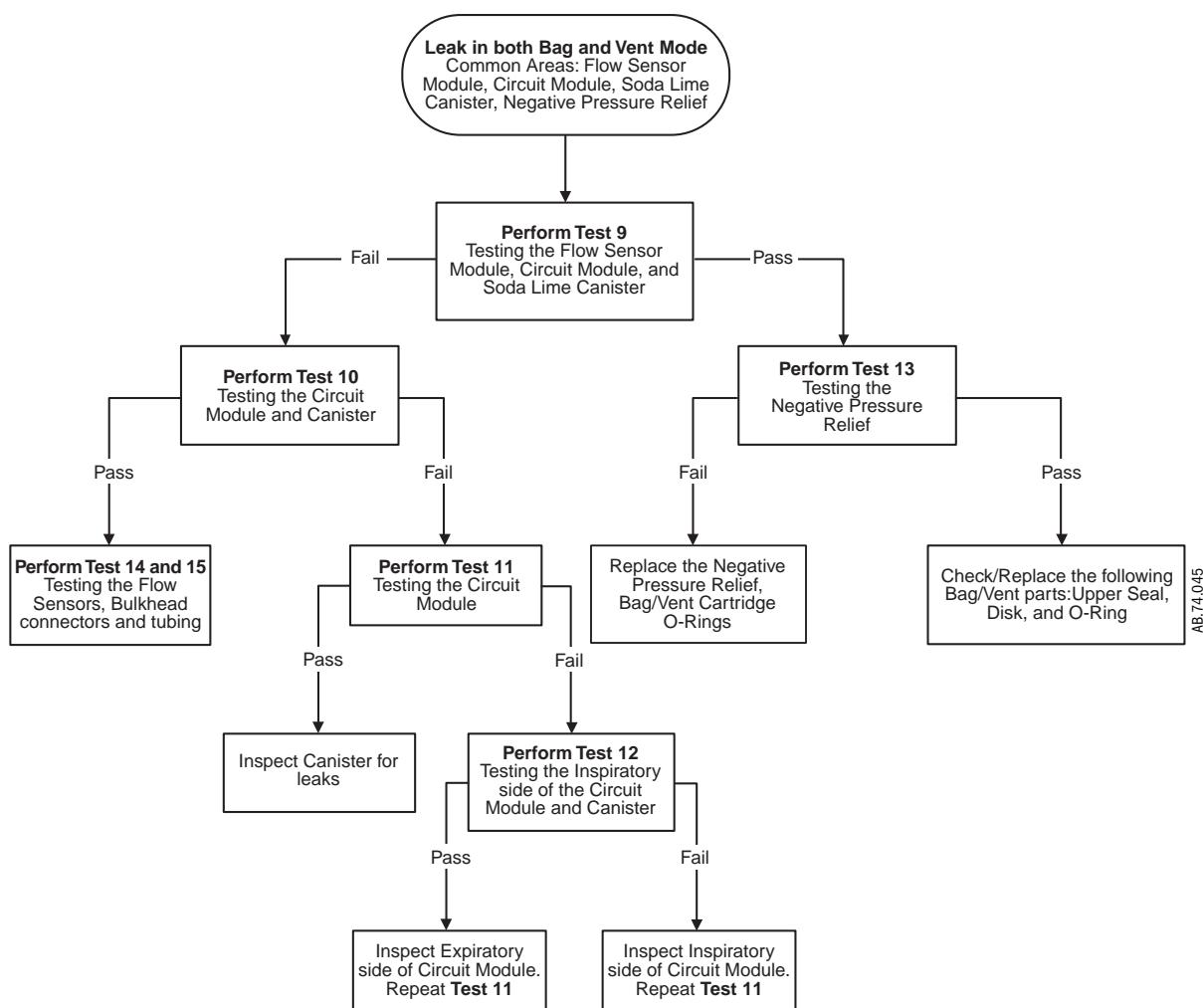
**Flowchart 1**



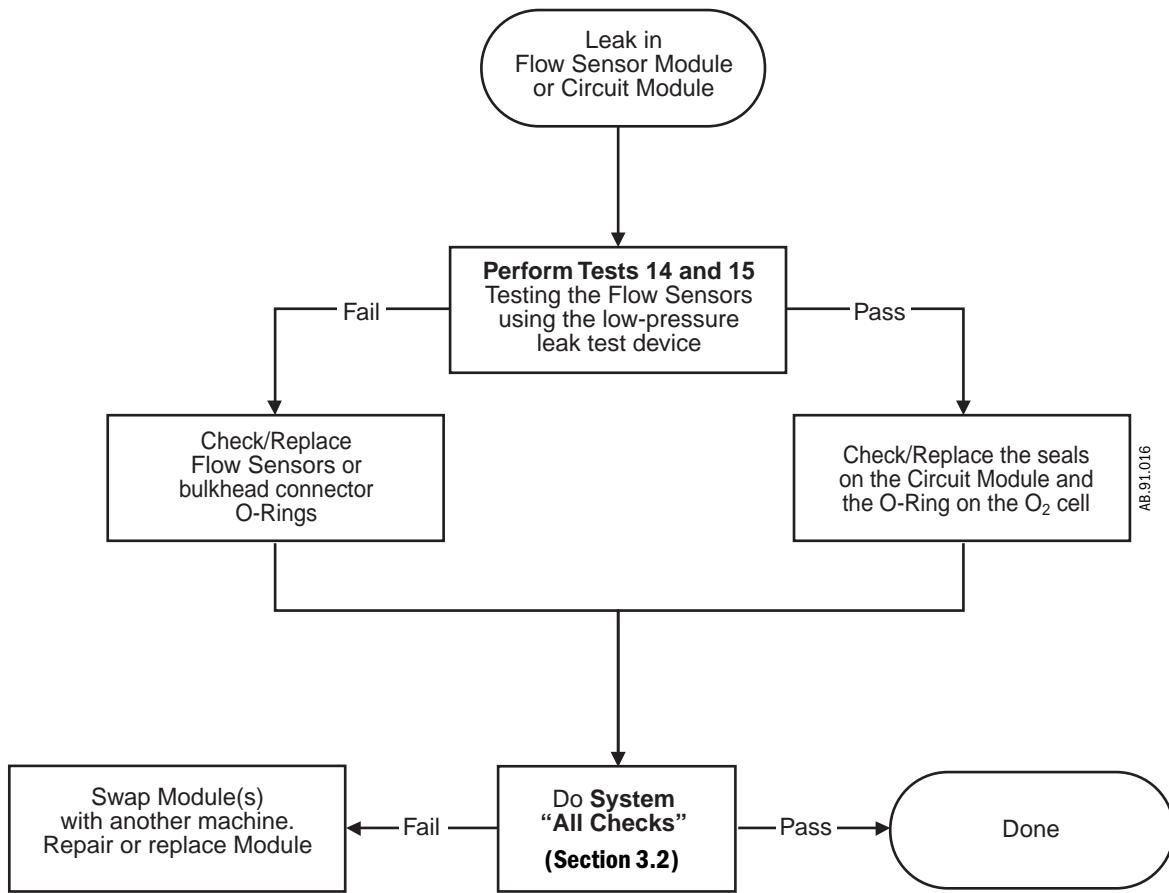
Flowchart 2



**Flowchart 3**



Flowchart 4



*Flowchart* **5**

### 7.2.3 Leak Isolation Tests

The previous flowcharts refer you to the following tests.

These tests require the use of the Low Pressure Leak Test Device and the Leak Test Tool Kit (refer to Section 10.1, "Service tools").

The Leak Test Tool Kit includes:

- the Machine Test Tool
- the Circuit Test Tool
- and various Test Plugs

When performing these tests on machines with an ACGO outlet, ensure that the ACGO selector switch is set to the ABS (Circle circuit) position.

<b>Note</b>	To perform most of these tests, you must boot the system with the PCMCIA Service Application and access the Diagnostics function as described in the test and detailed in Section 8.
<b>Test 1</b>	Verifying the integrity of the test tools..... 7-12
<b>Test 2</b>	Low-pressure leak testing the machine ..... 7-13
<b>Test 3</b>	Testing the airway pressure transducer, and Port 1 and Port 3 u-cup seals ..... 7-14
<b>Test 4</b>	Testing the bag port cover, the APL valve, the Bag/Vent switch, and the negative pressure relief valve ..... 7-15
<b>Test 5</b>	Testing the APL diaphragm ..... 7-16
<b>Test 6</b>	Testing the bellows module and the Bag/Vent switch ..... 7-17
<b>Test 7</b>	Testing the bellows, the bellows pop-off valve, the bellows base manifold, and the Bag/Vent switch ..... 7-18
<b>Test 8</b>	Testing the bellows assembly ..... 7-19
<b>Test 9</b>	Testing the flow sensor module, the circuit module, and the soda lime canister . 7-20
<b>Test 10</b>	Testing the circuit module and the canister..... 7-21
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#### **WARNING**

Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

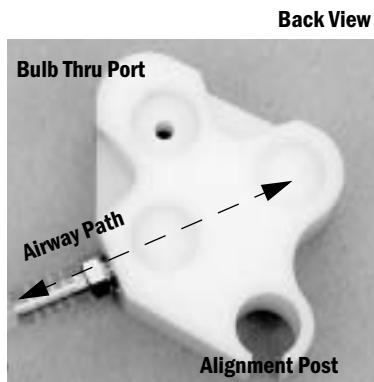
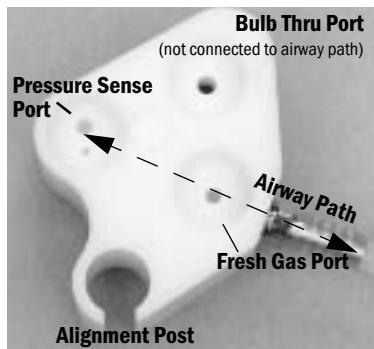
- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

#### **CAUTION**

Do not use O<sub>2</sub> Flush for leak isolation tests. Do not leave pressurized systems unattended. High pressure and equipment damage may result.

## Test 1 Verifying the integrity of the test tools

**Machine Test Tool**  
Front View



1. Verify integrity of low-pressure leak test device.
  - Put your hand on the inlet of the leak test device. Push hard for a good seal.
  - Squeeze the bulb to remove all air from the bulb.
  - If the bulb completely inflates in less than 60 seconds, replace the leak test device.

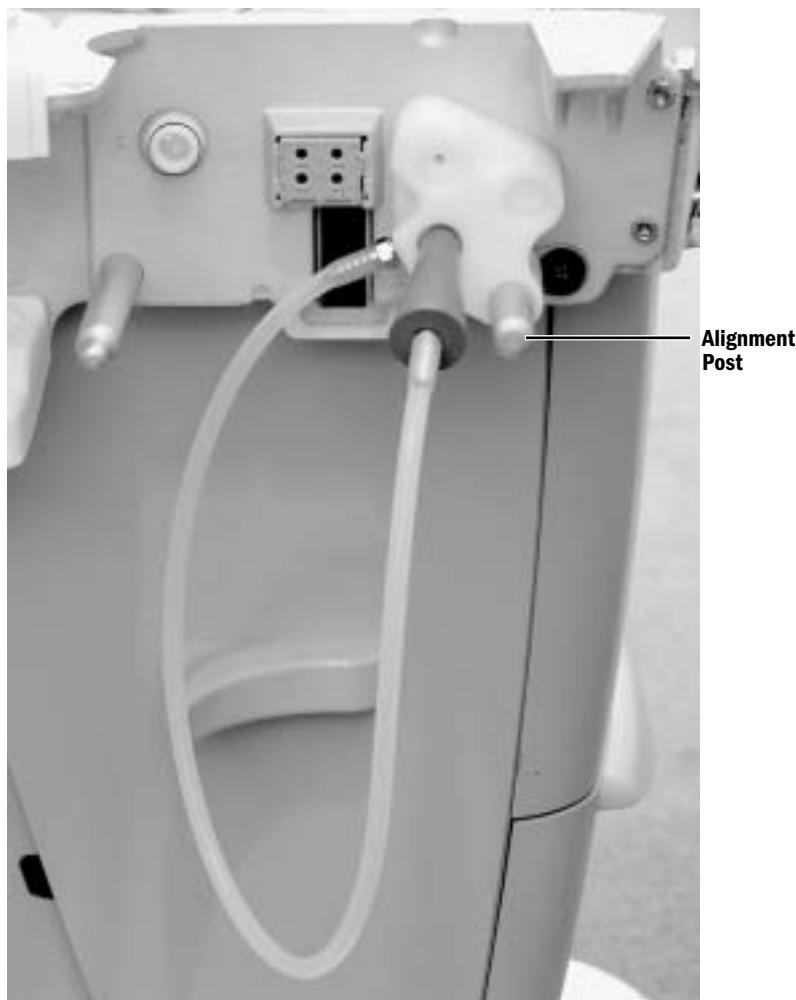


2. Attach the low-pressure leak test device to the Machine Test Tool.
3. Plug the two pressure orifices.
4. Repeatedly squeeze and release the hand bulb until it remains collapsed.
5. If the bulb inflates in less than 30 seconds, locate and correct the leak.

**Test 2 Low-pressure leak testing the machine**

1. Remove the breathing system from the machine.
2. Attach the Machine Test Tool (using only the Thru Port) and the low-pressure leak test device to **Port 3** of the breathing system interface as shown above.  
**Note:** To prevent damage to the airway pressure transducer, ensure that the gauge port (**Port 1**) is not connected to the Test Tool.
3. On the Main Menu of the Service Application, select **Vent Diagnostics**.
4. On the Vent Diagnostics page, select **Status**:
  - Ensure that the **Circuit Setting** shows “Circle”. If not, select **Toggle Circuit** in the Vent Diagnostics menu selections.
  - For machines with an ACGO outlet, ensure that the ACGO selector switch is set to the ABS (circle breathing circuit).
5. Turn off all vaporizers.
6. Compress and release the bulb until it is empty.
7. If the bulb completely inflates in 30 seconds or less, there is a leak in the low-pressure circuit.

**Test 3 Testing the airway pressure transducer,  
and Port 1 and Port 3 u-cup seals**



1. On the Main Menu of the Service Application, select **Gas Diagnostics**.
2. On the Gas Diagnostics page, select **O<sub>2</sub> Flow**.
3. Set O<sub>2</sub> Flow to **0.2 l/min.**
4. Attach the Machine Test Tool to the breathing system interface ports (using the alignment post) as shown above.
5. Occlude the tapered plug.
6. On the Gas Diagnostics page, reselect the **O<sub>2</sub> Flow** screen.
  - the Airway Pressure reading should increase.
  - If not, there is a leak in the tested circuit.
7. Set **O<sub>2</sub> Flow** to OFF.

**Test 4 Testing the bag port cover, the APL valve, the Bag/Vent switch, and the negative pressure relief valve**

1. Separate the Bellows Module from the Circuit Module and re-install the Bellows Module.
2. Occlude the Bag Port connector.
3. Connect the Machine Test Tool to the interface ports as shown above.
4. Set the Bag /Vent switch to Bag and close the APL Valve (70 cm H<sub>2</sub>O).
5. On the Main Menu of the Service Application, select **Gas Diagnostics**.
6. On the Gas Diagnostics page, select **O<sub>2</sub> Flow**.
7. Set O<sub>2</sub> Flow to **0.2 l/min**.
8. On the Gas Diagnostics page, reselect the **O<sub>2</sub> Flow** screen.
  - Ensure that the Airway Pressure rises to ≥ 30 cm H<sub>2</sub>O.
9. Set **O<sub>2</sub> Flow** to OFF.

**Note:** If the bellows rises, it indicates a leak in the Bag /Vent Switch.

### Test 5 Testing the APL diaphragm



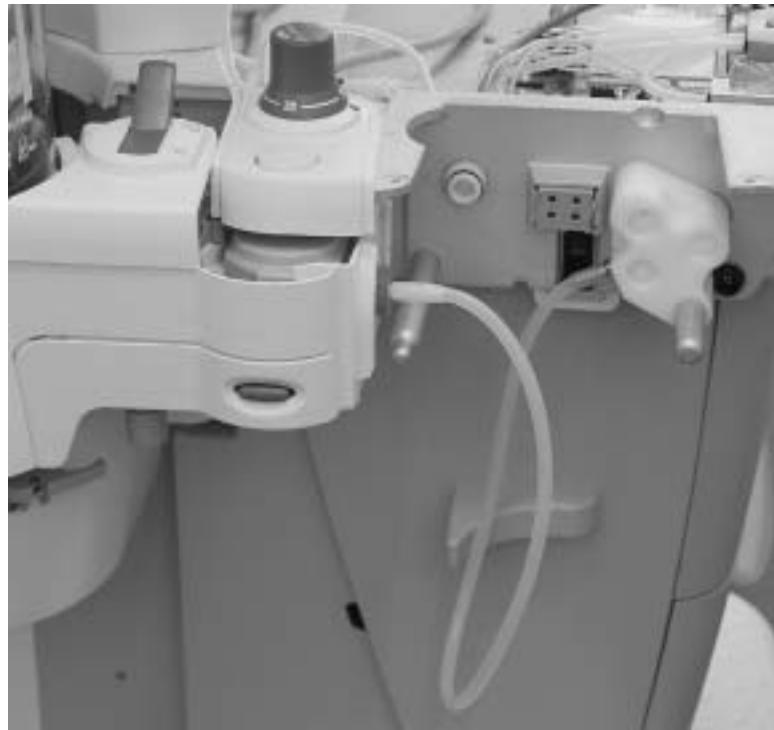
**Note** If required, set up the Machine Test Tool and breathing system as shown in Test 4.

1. Slide the Bellows Module away from the machine.
2. Remove the APL ramp and diaphragm.
3. Insert a Test Plug into the APL scavenging port, as shown above.
4. Slide the Bellows Module partially back onto the machine casting.
5. Ensure that the Bag Port is plugged and that the Bag/Vent switch is set to Bag.
6. On the Main Menu of the Service Application, select **Gas Diagnostics**.
7. On the Gas Diagnostics page, select **O<sub>2</sub> Flow**.
8. Set O<sub>2</sub> Flow to **0.2 l/min**.
9. On the Gas Diagnostics page, reselect the **O<sub>2</sub> Flow** screen.
  - Ensure that the Airway Pressure rises to  $\geq 30 \text{ cm H}_2\text{O}$ .
10. Set **O<sub>2</sub> Flow** to OFF.

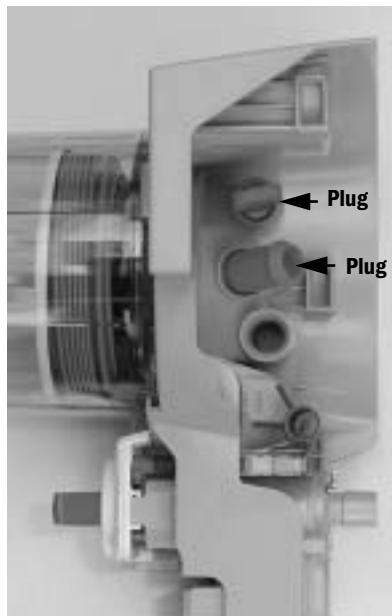
**Test 6 Testing the bellows module and the Bag/Vent switch**

1. Separate the Bellows Module from the Circuit Module and re-install the Bellows Module.
2. Connect the Machine Test Tool to the interface ports as shown above.
3. Set the Bag/Vent switch to the Vent position.
4. On the Main Menu of the Service Application, select **Gas Diagnostics**.
5. On the Gas Diagnostics page, select **Breathing Sys Leak** to access the Breathing Sys Leak screen (Section 8.2.6).
6. Set O<sub>2</sub> Flow to **0.2 l/min**.
  - Ensure that the Airway Pressure rises to  $\geq 30 \text{ cm H}_2\text{O}$ .
7. Press the ComWheel to Exit the Breathing Sys Leak test.
8. Set **O2 Flow** to OFF.

**Test 7 Testing the bellows, the bellows pop-off valve, the bellows base manifold, and the Bag/Vent switch**



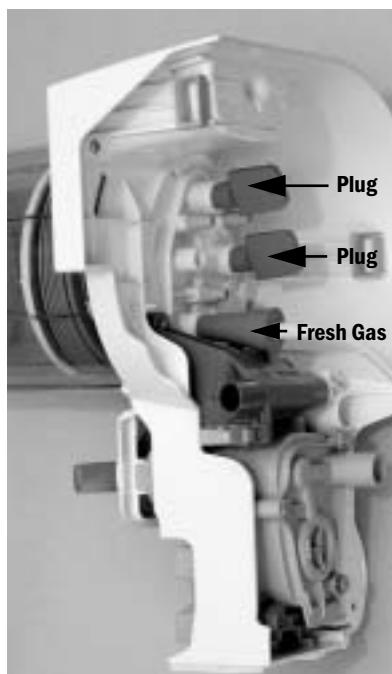
1. Separate the Bellows Module from the Circuit Module.
2. Insert appropriate test plugs into the bellows base manifold as shown to the left.  
**Note:** Position the bellows assembly so that the bellows remain collapsed as you plug the ports.
3. Set Bag/Vent switch to Vent.
4. Position the bellows upright with the bellows collapsed.
5. Connect the Machine Test Tool to the interface ports as shown above.
6. On the Main Menu of the Service Application, select **Gas Diagnostics**.
7. On the Gas Diagnostics page, select **O<sub>2</sub> Flow**.
8. Set O<sub>2</sub> Flow to **0.2 l/min**.
9. On the Gas Diagnostics page, reselect the **O<sub>2</sub> Flow** screen.
  - Ensure that the Airway Pressure rises to  $\geq 30 \text{ cm H}_2\text{O}$ .
10. Set **O<sub>2</sub> Flow** to OFF.



**Test 8 Testing the bellows assembly**

**Note** If required, set up the Machine Test Tool and breathing system as shown in Test 7.

1. Remove the bellows base manifold from the Bellows Module.
2. Insert appropriate test plugs into the bellows base manifold as shown to the left.  
**Note:** Position the bellows assembly so that the bellows remain collapsed as you plug the ports.
3. Connect the tapered plug of the Machine Test Tool to the bellows base inlet as shown to the left.
4. Position the bellows upright with the bellows collapsed.
5. On the Main Menu of the Service Application, select **Gas Diagnostics**.
6. On the Gas Diagnostics page, select **O<sub>2</sub> Flow**.
7. Set O<sub>2</sub> Flow to **0.2 l/min**.
8. On the Gas Diagnostics page, reselect the **O<sub>2</sub> Flow** screen.
  - Ensure that the Airway Pressure rises to ≥ 30 cm H<sub>2</sub>O.
9. Set **O<sub>2</sub> Flow** to OFF.



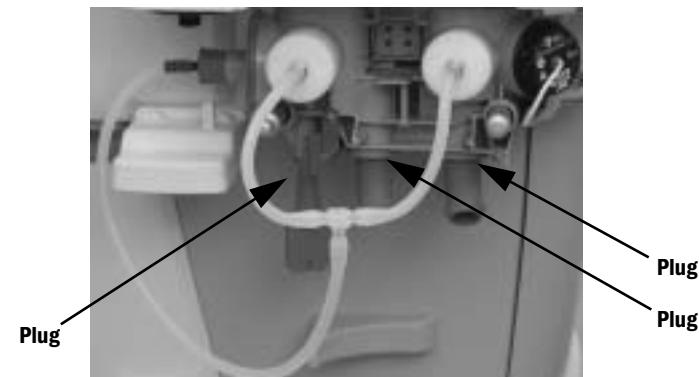
**Test 9    Testing the flow sensor module, the circuit module, and the soda lime canister**



1. Separate the Bellows Module from the Circuit Module and re-install the Circuit/Flow Sensor Module.
2. Connect short tubing between the inhalation and exhalation ports of the breathing system.
3. Insert an appropriate test plug in the outlet port of the Circuit Module.
4. On the Main Menu of the Service Application, select **Gas Diagnostics**.
5. On the Gas Diagnostics page, select **O2 Flow**.
6. Set O<sub>2</sub> Flow to **0.2 l/min**.
7. On the Gas Diagnostics page, reselect the **O2 Flow** screen.
  - Ensure that the Airway Pressure rises to ≥ 30 cm H<sub>2</sub>O.
8. Set **O2 Flow** to OFF.
9. Remove the plug to release pressure.

**Test 10 Testing the circuit module and the canister**

1. Remove the Flow Sensor module.
2. Connect the Circuit Test Tool to the Circuit Module as shown above.
3. Set O<sub>2</sub> Flow to **0.2 l/min**.
4. On the Gas Diagnostics page, reselect the **O2 Flow** screen.
  - Ensure that the Airway Pressure rises to ≥ 30 cm H<sub>2</sub>O.
5. Set **O2 Flow** to OFF.

**Test 11 Testing the circuit module**

**Note:** If required, set up the machine as in Test 10.

1. Remove the Soda Lime Canister.
2. Using appropriate Test Plugs, plug the three canister ports in the Circuit Module as shown above.
3. Set O<sub>2</sub> Flow to **0.2 l/min**.
4. On the Gas Diagnostics page, reselect the **O2 Flow** screen.
  - Ensure that the Airway Pressure rises to ≥ 30 cm H<sub>2</sub>O.
5. Set **O2 Flow** to OFF.

**Test 12 Testing the inspiratory side of the circuit module**

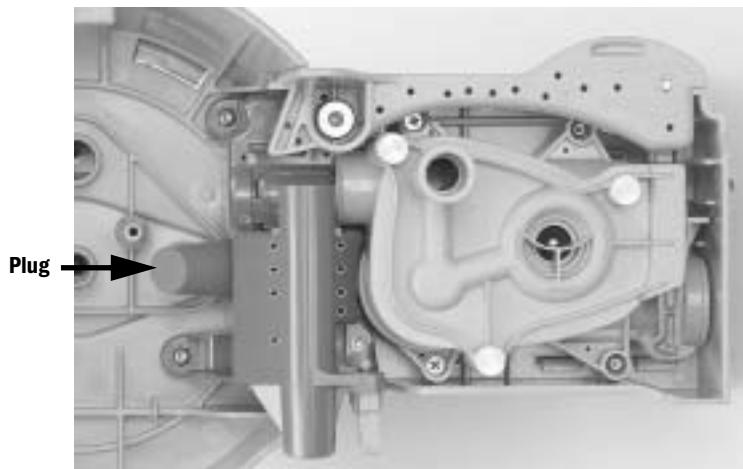


**Note:** If required, set up the machine as in Test 10 and 11.

1. Connect the Circuit Test Tool to the Circuit Module as shown above.
2. Insert an appropriate test plug in the inspiratory outlet to the canister as shown above.
3. Set O<sub>2</sub> Flow to **0.2 l/min.**
4. On the Gas Diagnostics page, reselect the **O2 Flow** screen.
  - Ensure that the Airway Pressure rises to  $\geq 30 \text{ cm H}_2\text{O}$ .
5. Set **O2 Flow** to OFF.

**Test 13 Testing the negative pressure relief valve**

1. Separate the Bellows Module from the Circuit Module.
2. Remove the Bellows Interface Manifold.
3. Insert test plug (recessed end) into the rear Bag/Vent switch port as shown.

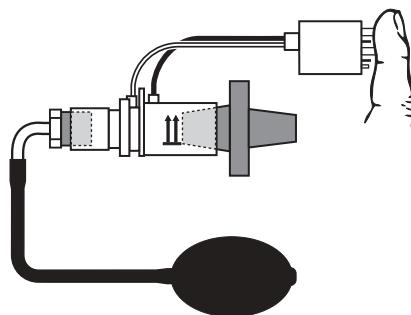


4. Install the Bellows Module.
5. Connect the Machine Test Tool to the interface ports and the Bellows Module as shown above.

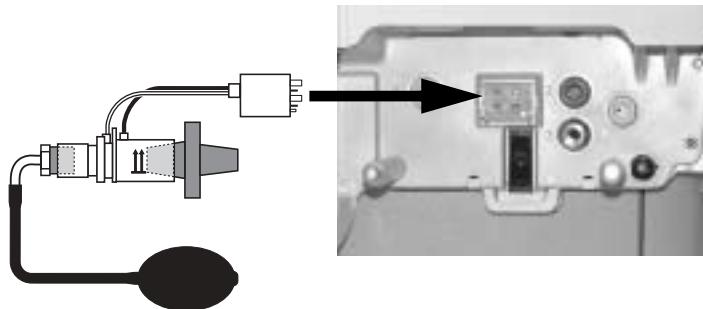


6. Set the Bag/Vent Switch to Vent.
7. Set O<sub>2</sub> Flow to **0.2 l/min**.
8. On the Gas Diagnostics page, reselect the **O<sub>2</sub> Flow** screen.
  - Ensure that the Airway Pressure rises to ≥ 30 cm H<sub>2</sub>O.
9. Set **O<sub>2</sub> Flow** to OFF.

**Test 14 Testing the flow sensors only**



1. Remove the Flow Sensor Module.
2. Plug each Flow Sensor as shown above.
3. Connect the low-pressure leak test device to the open end of the Flow Sensor.
4. Block the connector end of the Flow Sensor with your hand.
5. Compress and release the bulb until it is empty.
6. If the bulb inflates in 30 seconds or less, there is a leak in the flow sensor.
7. If there are no leaks in the flow sensors, go to Test 15.

**Test 15 Testing a flow sensor including the Ventilator Monitoring Assembly and interfacing components**

1. Remove Flow Sensors from the Flow Sensor Module.
2. Attach the Flow Sensor to the bulkhead connector.
3. Plug each Flow Sensor as shown.
4. Connect the low-pressure leak test device to the open end of the Flow Sensor.
5. Compress and release the bulb until it is empty.
6. If the bulb inflates in 30 seconds or less, there is a leak. The leak may be through the connector o-rings, in the internal tubing, or in the Transducer on the VIB.

## 7.3 Technical Alarms

The Error Log includes technical alarms and other error conditions reported by the system.

A technical alarm, as apposed to a parameter alarm, is an alarm condition that exists whether or not a patient is connected to the machine. Technical alarms include:

- Failed state alarms - internal problem prevents normal operation
- Ventilator failure alarms
- Vent Fail. Monitoring Only alarms
- Alternate O<sub>2</sub> state alarms - caused by electronic gas mixer failure

Alarms that do not fit into any particular category but are technical in nature are referred to as a Status alarms in this table.

Source table: AC = Anesthesia Computer

DC = Display Controller

Vent = Ventilator Interface

PC = Power Controller

Mixer = Electronic Gas Mixer

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
<b>Action/Troubleshooting</b>					
+12.0V H AMPS GAS SEL VALVES	Alternate O <sub>2</sub> Screen.	AC detected high current to the Gas Select Valves.	Medium	AC	Fresh gas select valves +10VA is turned On.
Disconnect the flex cable from each three-way and NC gas select valves. Measure the resistance of each valve: <ul style="list-style-type: none"><li>▪ should be approximately 75Ω.</li></ul>					
+12.0V H AMPS ALT O <sub>2</sub>	Alternate O <sub>2</sub> Screen.	AC detected high current.	Medium	AC	Alternate O <sub>2</sub> valve +10VA turned On.
Disconnect the flex cable from the NO Alternate O <sub>2</sub> valve. Measure the resistance of the NO Alternate O <sub>2</sub> Bypass Valve: <ul style="list-style-type: none"><li>▪ should be approximately 75Ω</li></ul>					
+12.0V H AMPS MIXER	Alternate O <sub>2</sub> Screen.	Status bit shows current high.	Medium	AC	Mixer +10VA turned On.
Disconnect the flex cable from the NO Alternate O <sub>2</sub> valve. Measure the resistance of the NO Alternate O <sub>2</sub> Bypass Valve: <ul style="list-style-type: none"><li>▪ should be approximately 75Ω.</li></ul>					
+12.0V H AMPS VENTSIB	See Section 7.7.2.5 Ventilator failure!	Status bit shows current high.	High	AC	Ventilator Interface board 10VA is turned on.
Reboot system. If problem continues, replace VIB.					

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
<b>Action/Troubleshooting</b>					
+12.0V H AMPS MGAS	Gas monitoring not available	Status bit shows current high.	Medium	AC	MGAS 10 VA is turned On
		Remove Gas Module from the Module Bay. If the problem continues, replace the M-Gas Monitoring board. If the message disappears when module is removed, repair the M-Gas module: ▪ (see S/5 AM Technical Reference Manual for repair instructions).			
+12.0V H AMPS VENT&OUTLET VALVES	Vent Fail. Monitoring Only.	Status bit shows current high.	Medium	AC Vent	Ventilator valves +10VA is On.
		Disconnect the GIV and Insp Flow Valve. Measure the resistance of each valve: ▪ should be approximately 25Ω for the GIV and 75Ω for the Insp Flow Valve.			
+12.5V TO ACB O <sub>2</sub>	See 7.7.2.4 Alternate	<11.9 or > 12.9 Vdc	High	AC - DC checks the service state.	
		Reboot system. If problem continues, replace the Power Controller board.			
+5V H AMP GAS SUPPLY XDUCERS	Cannot read gas supply pressures	Status bit shows current high.	Medium	AC	Pressure transducer +10VA turned On.
		Reboot system. If problem continues: 1. With system in Standby, disconnect all gas supply pressure transducers from ABS Filter board. 2. Reboot system. ▪ If problem continues, replace the ACB. ▪ If error is no longer present, set system to Standby and reconnect one pressure transducer at a time. 3. Reboot system and check for error with each transducer connected. Replace the transducer that causes the error to appear.			
12 HR TEST	Turn power Off and On for self tests	System has been operating for longer than 12 hours without a power up self test.	Low	AC - Vent DC checks enable criteria	System state is in Checkout.
		At next available time, move the system switch from the On position to the Off position, then back to the On position.			
ACB 4.096V ADC REF	Cannot monitor gas supplies	<4.018 or > 4.176 Vdc	Low	AC	
		Reboot System. If problem continues, replace the ACB.			
ACB ADC FAIL	Cannot monitor gas supplies	ADC timeout on any MUX channel.	Low	AC	
		Reboot System. If problem continues, replace the ACB.			
ACB CLOCK SPEED	System Malfunction	clock frequency > 1.1 • expected value or <0.9* expected value. AC Clock frequency incorrect.	High	AC	
		Reboot System. If problem continues, replace the ACB.			

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
<b>Action/Troubleshooting</b>					
ACB COM FAIL	System Malfunction	After establishing initial communication, the DC does not receive any messages from AC in 10 sec.	High	DC	
		Reboot System. If problem continues, replace the ACB.			
ACB CPU TEST FAIL	System Malfunction	CPU instruction Test Failure	High	AC	
		Reboot System. If problem continues, replace the ACB			
ACB DCB COM FAIL	System Malfunction	The Anesthesia Computer receives no system state messages from the Display Computer for 10 seconds.	High	AC	Initial communications established.
		Reboot System. If problem continues, check the ACB to Mixer communication LED's (or VIB communication LED's). If the RCV and XMT (or TXD and RXD) LED's indicate activity, check DU cable connections, replace Display Controller PCB if problem continues. If the RCV and XMT (or TXD and RXD) LED's indicate no activity, check the Anesthesia Control board connection, replace the Anesthesia Control board if problem continues.			
ACB EEPROM FAIL	Memory (EEPROM) failure	Read/Write failure or CRC failure of the EEPROM located on the Anesthesia Control Board.	Low	AC	
		Reboot System. If problem continues, replace the ACB.			
ACB FLASH FAIL	System Malfunction	CRC Failure in code space.	High	AC	
		Reboot System. If problem continues, replace the ACB.			
ACB HW WATCHDOG	System Malfunction	Hardware watchdog fails boot up test, times out, or detects an incorrect code sequence	High	AC	
		Reboot System. If problem continues, replace the ACB.			
ACB MICROPROC ERROR	System Malfunction	Unexpected microcontroller exception (bus error, address error, etc.)	High	AC	
		Reboot System. If problem continues, replace the ACB.			
ACB RAM ERROR	System Malfunction	Memory Test Failure, Multiple bit errors detected.	High	AC	
		Reboot System. If problem continues, replace the ACB.			
ACB REDUNDANT MEMORY FAIL	System Malfunction	A redundantly stored parameter could not be stored properly or was corrupted.	High	AC	
		Reboot System. If problem continues, replace the ACB.			
ACB SW ERROR	System Malfunction	Unexpected software error	High See 7.7.2.3 failed state	AC	
		Reboot System. If problem continues, reload ACB Software. If problem continues, replace the ACB.			

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
<b>Action/Troubleshooting</b>					
ACB SW WATCHDOG	System Malfunction	Software watchdog failed power-up test, timed out, or a software function was delinquent for too long.	High	AC	
Reboot System. If problem continues, replace the ACB.					
ACB UNEXPECTED RESET	System Malfunction	Unexpected reset of AC	High	AC	
Reboot system. If problem continues, replace the ACB.					
ACGO	Vol and Apnea monitoring off	Non Circle (ACGO) selected	Low	DC	System has ACGO
No Service Action Required.					
ACMains POWER FAIL	Plug in power cable. On battery	ACMains_GOOD goes and stays low for at least 300 msec (3 software loops)	Medium	PC	30 minutes of battery power available.
No Service Action Required.					
AIR PIPE INVALID	Cannot monitor Air pipeline	Air Pipeline pressure is invalid.	Medium	DC	
Check Air Pipeline Supply. Check/Replace Air Pipeline Pressure Transducer.					
AIR PRESS LOW	Air supply pressure low	Air pipeline pressure is less than 252 kPa and the air cylinder has a pressure less than 2633 kPa for one second.	Medium	AC, DC	Air is selected as the balance gas with a non zero flow of air or the ventilator uses air as the drive gas and mechanical ventilation is ON
Check Air Supply. Check/Replace Air Pipeline/Cylinder Pressure Transducer					
AIRWAY SENSOR CAL ERROR	Calibrate flow sensors	Airway Pressure Sensor zero offset out of range	Low	AC, Vent	Flow sensor detected
In the Service Software / Vent Flow & Pressure Diagnostics, verify the Airway Pressure counts is $800 \pm 250$ . Disconnect the Black in-line connector in the Patient Airway. If the counts return within specified range, check for occlusions in the Bulkhead harness. If the counts do not return within the specified range, replace the VIB.					
ALT O2 SWITCH FAIL	Alternate O <sub>2</sub> switch status indicates Alt O <sub>2</sub> switch fault. The fault detection condition must persist for 1 second.		Medium	AC	
Replace the Alt O <sub>2</sub> Switch.					

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
<b>Action/Troubleshooting</b>					
AUX OUTLET FAIL	No fresh gas flow?	The measured SCGO position does not match commanded position.	High	AC, Vent	
In the Service Software / Vent Diagnosis, view the Circuit Feedback status. If the feedback indicates "Fault", toggle the Circuit. If the Status changes to match the Circuit setting, check / replace the SCGO / ACGO Micro-switches.					
BACKUP MODE ENTERED	Backup Mode active	No spontaneous breaths in set period of time (Backup Time (sec)) and 30 seconds has elapsed since starting PSVPro mode.	Low	DC	
No spontaneous breaths in set period of time (Apnea time) and 30 seconds has elapsed since starting PSVPro mode. No Service Action Required.					
BAL FLOW CTRL FAIL		Mixer status bit STS_FLOW_CTRL_CH2_FAIL indicates flow attainment failure.	Medium	AC, Mixer	Balance gas supply pressure OK
Reboot System. If problem continues, replace the Mixer.					
BAL PROP VALVE FAIL		Mixer status bit STS_CH2_PROPN VALVE FAIL indicates proportional valve failure (over current, etc.)	Medium	AC, Mixer	
Reboot System. If problem continues, replace the Mixer.					
BATT V VERY LOW	Plug in power cable. On battery	Available battery power decreases to between 10 and 5 min	Medium	PC	AC Mains Power Failure in progress.
Leave the system plugged in to charge the battery. If problem continues, check the battery charge circuit in Service Software. Replace Battery.					
BATTERY <1MIN	System shutdown in <1min	Available battery power is <1min	High	PC	AC Mains Power Failure in progress.
Leave the system plugged in to charge the battery. If problem continues, check the battery charge circuit in Service Software. Replace Battery.					
BATTERY CHARGE FAIL	No battery backup	The system is in standby and the battery charge current is >4.0 amps for Or The system is powered on with a battery current >1.3 amps.	Medium	PC	
Check the battery charge circuit in Service Software. Replace Battery.					

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
<b>Action/Troubleshooting</b>					
BATTERY EMPTY	System shutdown in <5 min	Available battery power is between 1 and 5 minutes	High	PC	AC Mains Power Failure in progress.
	<p>Leave the system plugged in to charge the battery.            If problem continues, check the battery charge circuit in Service Software.            Replace Battery.</p>				
BATTERY FAIL	No Battery Backup.	Battery voltage <10.5 V or  While in bulk, over, or float charging battery is <10.5VDC or  Battery has been bulk charging for >12 h in Standby or 24 h while powered on. Or Voltage > 15.5V during bulk or over charging and normal current >0.25 Amps	Medium	PC	
	<p>Leave the system plugged in to charge the battery.            If problem continues, check the battery charge circuit in Service Software.            Replace Battery.</p>				
BATTERY LOW	Plug in power cable. On battery	Available battery power decreases to between 20 and 30 min	Medium	PC	Mains AC Mains Power Failure in progress.
	<p>Leave the system plugged in to charge the battery.            If problem continues, check the battery charge circuit in Service Software.            Replace Battery.</p>				
BATTERY MISSING	No battery backup	Any battery voltage is between ±1.0 VDC.	Medium	PC	POST state
	<p>Connect Battery            Leave the system plugged in to charge the battery.            If problem continues, check the battery charge circuit in Service Software.            Replace Battery.</p>				
BATTERY REVERSED CONNECTIONS	No battery backup	Any battery voltage is less than -1.0 VDC	Medium	PC	
	<p>Check Battery Connections</p>				
BATTERY V LOW	Plug in power cable. On battery	Available battery power decreases to between 10 and 20 minutes	Medium	PC	AC Mains Power Failure in progress.
	<p>Leave the system plugged in to charge the battery.            If problem continues, check the battery charge circuit in Service Software.            Replace Battery.</p>				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
Action/Troubleshooting					
BELLOWS COLLAPSED	Unable to drive bellows	Manifold pressure > Paw + 10 + (0.25* Inspiratory valve flow)	Low	AC, Vent	In range Paw and manifold pressure data available and mechanical ventilation On.
		Check the breathing circuit for leaks or hose occlusions. Perform flow sensor calibration. Check drive gas check valve. Check VIB cabling. Replace VIB.			
BREATHING SYSTEM NOT LATCHED	Breathing system loose	Breathing system detection switch indicates breathing system not latched	Low	AC, Vent	
CAL DATA FAILURE IN EEPROM	Service calibration advised	Default cal data is being used due to corrupt data in cal region.	Low	AC	
		Perform complete service level calibrations.			
CHECK FLOW SENSOR	Check flow sensors	During Mechanical breaths, the measured flow for 6 consecutive breaths, to and from the patient, does not meet certain criteria.  No or negative flow on Insp flow sensor during inspiration or negative flow on Exp flow sensor.	Medium	AC, Vent	In-range flow data available during mechanical ventilation
		Check flow sensor connections. Check the breathing circuit. Check VIB sensor tubing for leaks. Perform flow sensor calibration. Check Insp/Exp check valves. Replace flow sensors. Check			
COM ERROR VENT TO ACB	System Malfunction	After regular communications has been established between the Ventilator boundary object and the Vent SIB CPU, a total loss of communications shall be declared if the Ventilator boundary object receives no messages from the Vent SIB CPU for 35 milliseconds.	High	AC Vent	
		Reboot System. If problem continues: 1. Check cabling. 2. Replace VIB. 3. Replace ACB.			
DCB RAM ERROR	System Malfunction	Self test failure or multi bit error detected.	High	DC	
		Reboot System. If problem continues, replace the Display Controller Board.			

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
Action/Troubleshooting					
DRIVE GAS LOST	Ventilator has no drive gas	O <sub>2</sub> supply low if O <sub>2</sub> is selected drive gas OR AIR supply low if Air is selected drive gas.	High	AC DC checks enable criteria	Mechanical Ventilation is ON.
Connect O <sub>2</sub> or AIR supply. See Action/Troubleshooting for O <sub>2</sub> PRESS LOW or AIR PRES LOW.					
EXP FLOW SENSOR CAL ERROR	Calibrate flow sensors	Exp Flow Sensor zero offset out of range	Low	AC, Vent	Flow sensor detected
In the Service Software / Vent Flow & Pressure Diagnostics, verify the Expiratory Flow counts is 2050 ± 250. Disconnect the Blue and Yellow in-line connectors. If the counts return within specified range, check for occlusions in the Bulkhead harness. If the counts do not return within the specified range, replace the VIB.					
EXP FLOW SENSOR EEPROM FAILURE	Replace exp flow sensor	EEPROM cal data read failure	Low	AC, Vent	
Replace Exp Flow Sensor.					
FAN FAIL	Cooling fan needs service. System OK	Fan Power Status Bit is Low (FAN1_GOOD).	Medium	PC	Communication between DU and Display Computer.
Connect Pan or fan. Replace cooling fan. Replace Mixer.					
FLOW SENSOR CAL ERROR	Calibrate flow sensors	Insp or Exp flow sensor or the airway or manifold pressure sensor zero offset out of range (flow calibration failure)	Low	AC, Vent	Flow sensor detected
See associated Errors. i.e. EXP FLOW SENSOR CAL ERROR or AIRWAY SENSOR CAL ERROR					
FRONT PANEL COM FAIL	Display panel controls failure	Key pad controller fails to send "life tick" for greater than 10 Sec (Yellow)	Medium	DC	
Reboot system. If problem continues, replace Display Controller Board.					
GAS INLET VALVE BOOTUP	Vent Fail. Monitoring Only	Boot-up test failed	High	AC, Vent	
1. Check GIV solenoid connection. 2. Replace GIV. 3. Replace VIB.					
INSP FLOW SENSOR CAL ERROR	Calibrate flow sensors	Insp Flow Sensor zero offset out of range	Low	AC, Vent	Flow sensor detected
In the Service Software / Vent Flow & Pressure Diagnostics, verify the Inspiratory Pressure counts is 2050 ± 250. Disconnect the Black and White in-line connectors. If the counts return within specified range, check for occlusions in the Bulkhead harness. If the counts do not return within the specified range, replace the VIB.					

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
<b>Action/Troubleshooting</b>					
INSP FLOW SENSOR EEPROM FAILURE	Replace insp flow sensor	EEPROM cal data read failure	Low	AC, Vent	
Replace the Inspiratory Flow Sensor.					
LOSS OF GAS DELIVERY USER SETTINGS		After regular communications has been established between the AC and the Display Computer, this alarm shall be declared if the system is in the Therapy State and the AC determines the Gas Delivery User Settings from the Display Computer arrived more than 10 seconds ago.		AC	
<p>Reboot system. If problem continues, check the ACB to Mixer communication LED's (or VIB communication LED's).</p> <ol style="list-style-type: none"> <li>1. If the RCV and XMT (or TXD and RXD) LED's indicate activity,           <ul style="list-style-type: none"> <li>▪ check DU cable connections.</li> <li>▪ replace Display Controller board if problem continues.</li> </ul> </li> <li>2. If the RCV and XMT ( or TXD and RXD) LED's indicate no activity,           <ul style="list-style-type: none"> <li>▪ check the Anesthesia Control board connection.</li> <li>▪ replace the Anesthesia Control board if problem continues.</li> </ul> </li> </ol>					
LOSS OF VENT PARAMETER SETTINGS	Vent Fail. Monitoring Only	After regular communications has been established between the AC and the Display Computer, this alarm shall be declared if the system is in the Therapy State and the AC determines the Ventilator Parameter Settings from the Display Computer arrived more than 10 seconds ago.	Medium	AC	
<p>Reboot system. If problem continues, check the ACB to Mixer communication LED's (or VIB communication LED's).</p> <ol style="list-style-type: none"> <li>1. If the RCV and XMT (or TXD and RXD) LED's indicate activity,           <ul style="list-style-type: none"> <li>▪ check DU cable connections.</li> <li>▪ replace Display Controller board if problem continues.</li> </ul> </li> <li>2. If the RCV and XMT ( or TXD and RXD) LED's indicate no activity,           <ul style="list-style-type: none"> <li>▪ check the Anesthesia Control board connection.</li> <li>▪ replace the Anesthesia Control board if problem continues.</li> </ul> </li> </ol>					

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
<b>Action/Troubleshooting</b>					
MANIFOLD PAW SENSOR FAIL	Vent Fail. Monitoring Only	Calibration failure at bootup	Medium	AC, Vent	
In the Service Software / Vent Flow & Pressure Diagnostics, verify the Manifold Flow counts is $800 \pm 250$ . Disconnect the White in-line connector in the Manifold Pressure. If the counts return within specified range, check for occlusions in the Bulkhead harness. If the counts do not return within the specified range, replace the VIB.					
MGAS CHECK SAMPLE GAS OUT >20 SEC	Check sample gas out	MGAS SPEC. Continuous Occlusion Bit set.	Medium	MGAS	MGAS present and MGAS communicates continuous occlusion for 20 seconds
Replace sample line. See AM TRM for further Troubleshooting.					
MGAS INLET FILTER RESIDUE >40 SEC	Replace D-Fend	MGAS SPEC (Residue build-up on the water trap membrane. This decreases air flow)	Medium	MGAS	MGAS present and MGAS communicates this the Replace Trap alarm bit for 40 seconds
Replace D-Fend. See AM TRM for further Troubleshooting.					

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
Action/Troubleshooting					
MGAS LINE BLOCKED >20 SEC	Sample line blocked	MGAS SPEC states The sample tubing inside or outside the monitor blocked, or the water trap is occluded.	Medium	MGAS	MGAS present and MGAS communicates this the continuous occlusion alarm for 20 seconds
Replace sample line. See AM TRM for further Troubleshooting.					
MGAS SAMPLE LINE NOT CONNECTED >40 S	Check D-Fend	MGAS SPEC states The sample tubing or the D-Fend module is not installed	Medium	MGAS	MGAS present and MGAS communicates this the OpenGasCircuit alarm for 40 seconds
Replace D-Fend. See AM TRM for further Troubleshooting.					
MGAS SENSOR INOP > XX	Module fail. No CO <sub>2</sub> , AA, O <sub>2</sub> data	MGAS SPEC Mgas communicates hardware failure (RAM failure; ROM checksum error; Error in CPU eeprom; Error O <sub>2</sub> preamp eeprom; Error in SSS board eeprom; Voltage error; Lamp control failure.) or UPI does not initialize	Medium	MGAS	
See AM TRM for further Troubleshooting.					
MIXER BAL GAS CHANGE FAIL	Alternate O <sub>2</sub> Screen	Mixer Status Bit: STS__BALGAS_CHANGE_OVER_FAIL After the mixer commanded a change to the balance gas, the status of the selector valve shows the old balance gas is still connected.	Medium	AC, Mixer	
Reboot System. If problem continues, replace the Mixer.					
MIXER BALGAS Flow FAIL		Mixer error bit STS_CH2_DELTAP_FLOW_FAIL Pressure difference between P3 and P2 differs from the drop expected at the measured flow for channel 2 (Balance Gas)	Medium	AC, Mixer	
Reboot System. If problem continues, replace the Mixer.					
MIXER O2 Flow FAIL	Alternate O <sub>2</sub> Screen	Mixer error bit STS_CH1_DELTAP_FLOW_FAIL Pressure difference differs from the drop expected at the measured flow for Channel 1 (O <sub>2</sub> )	Medium	AC, Mixer	
Reboot System. If problem continues, replace the Mixer.					
MIXER ACB COM FAIL	Alternate O <sub>2</sub> Screen	Five seconds pass without measured flow data from the mixer.	Medium	AC	Communication has been established between mixer and AC.
Reboot System. If problem continues, replace the Mixer.					

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
<b>Action/Troubleshooting</b>					
MIXER ACB COM FAILLOST CMD	Alternate O <sub>2</sub> Screen.	Mixer status Bit STS_LOSS_OF_SETFLOW_CMD.	Medium	AC, Mixer	
Mixer has lost AC flow commands for 5 sec or received "illegal" commands.(hypoxic mix, settings not allowed)					
Reboot System. If problem continues, replace the Mixer.					
MIXER AIR SELECTION VLV FAIL	Alternate O <sub>2</sub> Screen.	Mixer Status Bit: STS_SELV_VAIR_NOTIFY_FAIL	Medium	AC, Mixer	
The status of the air selector valve does not match the commanded state.					
Reboot System. If problem continues, replace the Mixer.					
MIXER BAL GAS F SENSOR FAIL	Alternate O <sub>2</sub> Screen.	Mixer error bit STS_F2_SENSOR_FAIL	Medium	AC, Mixer	
Balance gas flow sensor failure					
Reboot System. If problem continues, replace the Mixer.					
MIXER BAL GAS TSENSOR FAIL	Alternate O <sub>2</sub> Screen.	Mixer error bit STS_T2_SENSOR_FAIL (Balance Gas).	Medium	AC, Mixer	
Balance gas temperature sensor failure.					
Reboot System. If problem continues, replace the Mixer.					
MIXER BAL GAS FLOW CHECK FAIL		Mixer status bit 1LPM_FLOW_TEST_FAIL. Bal gas proportional valve fails flow check STS_FLOW_TEST_BAL_CHAN_F Allshows balance gas proportional valve failed self test	Medium	AC, Mixer	
Reboot System. If problem continues, replace the Mixer.					
MIXER BAL GAS TEMP LIMIT	Alternate O <sub>2</sub> Screen.	Mixer error bit STS_CH2_TEMP_LIMIT (Balance Gas).	Medium	AC, Mixer	
Balance gas temperature exceeds 50 °C.					
Reboot System. If problem continues, replace the Mixer.					
MIXER BAL GAS ZERO FAILLEAK		Mixer status bit STS_CH2_ZERO_FLOWPROP_N_V _CH2_LEAK_FAIL_TEST_FAIL. Bal gas proportional valve fails zero flow check shows flow while closed	Medium	AC, Mixer	
Reboot System. If problem continues, replace the Mixer.					

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria		
Action/Troubleshooting							
MIXER CRC EEPROM FAIL	Alternate O <sub>2</sub> Screen	Runtime CRC check on EEPROM failed. Mixer Status Bit STS_EEPROM_CRC_FAIL	Medium	AC, Mixer			
Reboot System. If problem continues, replace the Mixer.							
MIXER CRC FLASH FAIL	Alternate O <sub>2</sub> Screen	Runtime CRC check on Flash failed. Mixer Status Bit STS_FLASH_CRC_FAIL	Medium	AC, Mixer			
Reboot System. If problem continues, replace the Mixer.							
MIXER CRC RAM FAIL	Alternate O <sub>2</sub> Screen	Runtime CRC walking pattern check on RAM failed. Mixer Status Bit STS_RAMCRC_FAIL	Medium	AC, Mixer			
Reboot System. If problem continues, replace the Mixer.							
MIXER N <sub>2</sub> O SELECTION VLV FAIL			Mixer Status Bit: STS_SELV_VN2_NOTIFY_FAIL	Medium	AC, Mixer		
The status of the N <sub>2</sub> O selector valve does not match the commanded state.							
Reboot System. If problem continues, replace the Mixer.							
MIXER O <sub>2</sub> TSENSOR FAIL	Alternate O <sub>2</sub> Screen.	Mixer error bit STS_T1_SENSOR_FAIL O <sub>2</sub> temperature sensor failure	Medium	AC, Mixer			
Reboot System. If problem continues, Replace the Mixer.							
MIXER O <sub>2</sub> F SENSOR FAIL	Alternate O <sub>2</sub> Screen	Mixer error bit STS_F2F1_SENSOR_FAIL (O <sub>2</sub> ). O <sub>2</sub> flow sensor fail	Medium	AC, Mixer			
Reboot System. If problem continues, replace the Mixer.							
MIXER O <sub>2</sub> FLOW CHECK FAIL			Mixer status bit STS_FLOW_TEST_CH1_FAIL1LP	Medium	AC, Mixer		
M_FLOW_TEST_FAIL. O <sub>2</sub> proportional valve fails flow check							
Reboot System. If problem continues, replace the Mixer.							
MIXER O <sub>2</sub> SELECTION VLV FAIL			Mixer Status Bit: STS_SELV_VOXY_NOTIFY_FAIL	Medium	AC, Mixer		
The status of the O <sub>2</sub> selector valve does not match the commanded state.							
Reboot System. If problem continues, replace the Mixer.							
MIXER O <sub>2</sub> TEMP LIMIT	Alternate O <sub>2</sub> Screen	Mixer error bit STS_CH1_TEMP_LIMIT (O <sub>2</sub> ). O <sub>2</sub> temperature exceeds 50 °C.	Medium	AC, Mixer			
Reboot System. If problem continues, replace the Mixer.							

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
Action/Troubleshooting					
MIXER O2 ZERO LEAK FAIL		Mixer status bit STS_CH1_ZERO_FLOW_TESPRO PN_V_LEAK_FAULT_FAIL_O2 proportional valve fails zero flow checks for leaks when it should be closed.	Medium	AC, Mixer	
Reboot System. If problem continues, replace the Mixer.					
MIXER P SENSOR P2 FAIL		Mixer error bit STS_PRESS_SENSOR_FAIL_P2 Pressure sensor 2 in the mixer has failed.	Medium	AC, Mixer	
Reboot System. If problem continues, replace the Mixer.					
MIXER POST FAIL	Alternate O <sub>2</sub> Screen	Mixer tells AC that Power Up Self Test Fail	Medium	AC, Mixer	
See associated Error in Error Log. i.e. "MIXER O <sub>2</sub> FLOW CHECK FAIL" or "Mix: FLOW VERIFICATION FAILURE (dP) CH1"					
MIXER PRES SENSOR P1P3 FAIL		Mixer error bit STS_PRESS_SENSOR_FAIL_P1P3 One of the O <sub>2</sub> pressure sensors in the mixer has failed.	Medium	AC, Mixer	
Reboot System. If problem continues, replace the Mixer.					
MIXER SW WDOG FAIL	Alternate O <sub>2</sub> Screen	Mixer status Bit STS_SW_WDOG_FAIL	Medium	AC, Mixer	
Reboot System. If problem continues, replace the Mixer.					
MIXER VOLTS FAIL	Alternate O <sub>2</sub> Screen	Mixer power supply (on board) is out of tolerance. Status bit STS_VOLT_REF_FAIL	Medium	AC, Mixer	+12.5 V (10 VA) to mixer OK.
In the Service Software / Mixer Power Diagnosis, view the "Mixer 10VA Voltage" from Anes Cntrl Bd: If "Mixer 10VA Volts" reads "OK, and +12.5 Vdc reads "Fail", replace the Mixer. If "Mixer 10VA Volts" reads "Fail", Check cabling between ACB and Mixer, replace ACB if ca.					
MODULE NOT COMPATIBLE	Module not compatible	The Monitoring Module detected is not compatible with system software. System is designed to work with the following Compact Airway Module versions: M-CaiO (HW rev 00 and above, SW rev 3.2 and above) and M-CaiOV (HW rev 00 and above, SW Rev 3.2 and above)	Low	DC	
Replace M-Gas module with compatible module.					

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
<b>Action/Troubleshooting</b>					
N2O PRESS LOW	N <sub>2</sub> O supply pressure low	N <sub>2</sub> O pipeline pressure is less than 252 kPa and the N <sub>2</sub> O cylinder pressure is less than 2633 kPa.	Low	AC	N <sub>2</sub> O is selected as the balance gas with a non zero flow of N <sub>2</sub> O
		Check N <sub>2</sub> O Supply. Check / Replace N <sub>2</sub> O Pipeline/Cylinder Pressure Transducer.			
NO EXPIRATORY FLOW SENSOR	No exp flow sensor	No Expiratory sensor connected and not calibrating	Medium	A, Vent	
		Connect Expiratory flow sensor. Check/Replace Bulkhead harness. Replace VIB Board.			
NO INSPIRATORY FLOW SENSOR	No insp flow sensor	No inspiratory sensor connected and not calibrating	Medium	AC, Vent	AC-Vent
		Connect Inspiratory flow sensor. Check/Replace Bulkhead harness. Replace VIB Board.			
02 PROP VALVE FAIL		Mixer status bit STS_CH1_PROPN_VALVE FAIL indicates proportional valve failure.	Medium	AC, Mixer	
		Reboot System. If problem continues, Replace the Mixer.			
02 FLOW CTRL FAIL		Mixer status bit STS_FLOW_CTRL_CH1_FAIL indicates flow control failure.	Medium	AC, Mixer	O <sub>2</sub> gas supply pressure OK
		Reboot System. If problem continues, Replace the Mixer.			
02 FLUSH FAILURE	O <sub>2</sub> flush stuck on?	Switch is detected "on" continuously > 30 sec	Low	AC, Vent	
		Alarm condition becomes false for 2 consecutive switch readings.			
02 PIPE INVALID	Cannot monitor O <sub>2</sub> pipeline	O <sub>2</sub> Pipeline pressure is invalid.	Medium	DC	
		Check O <sub>2</sub> Pipeline Supply. Check / Replace O <sub>2</sub> Pipeline Pressure Transducer			
02 PRESS LOW	O <sub>2</sub> supply pressure low	O <sub>2</sub> pipeline pressure is less than 252 kPa and the O <sub>2</sub> cylinder has a pressure less than 2633 kPa for one second.	High	AC, DC	N <sub>2</sub> O flow stops on threshold detection and Air continues to flow if selected.
		Check O <sub>2</sub> Supply. Check / Replace O <sub>2</sub> Pipeline/Cylinder Pressure Transducer			

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
<b>Action/Troubleshooting</b>					
O2 SENSOR FAILURE	Replace O <sub>2</sub> sensor	O <sub>2</sub> < 5%	Low	AC, Vent	Galvanic O <sub>2</sub> sensor connected
Calibrate O <sub>2</sub> Sensor. If calibration fails, replace O <sub>2</sub> Sensor. If calibration continues to fail, wait 90 minutes and repeat calibration. If calibration fails after 90 minute, replace VIB					
O2CAL ERROR	Calibrate O <sub>2</sub> sensor	Offset, slope, or cell voltage not in range or O <sub>2</sub> > 110%	Low	AC, Vent	Galvanic O <sub>2</sub> sensor connected
Calibrate O <sub>2</sub> Sensor. If calibration fails, replace O <sub>2</sub> Sensor. If calibration continues to fail, wait 90 minutes and repeat calibration. If calibration fails after 90 minute, replace VIB.					
PATIENT VOLUME MISMATCH OCCURRED	Calibrate, dry, or replace flow sensors	PATIENT VOLUME MISMATCH alarm occurred.	Low	AC, Vent, DC checks enable criteria	System state is in Checkout.
1. Check flow sensor connections. 2. Replace flow sensors. 3. Check the VIB tubing for moisture. 4. Replace VIB.					
PCSELF TEST	Internal failure. System may shut down	PC failed self tests (memory, voltages, or CPU).	High	PC	
Reboot system. If problem continues, check power supplies in the Service Software. Replace Power Controller Board if continues.					
PEEP PCV NOT AVAILABLE	Vol vent only. No PEEP or PSV	Paw data is in range but the Pmanifold <= -15 cmH <sub>2</sub> O	Medium Or Low	DC	None
Perform flow sensor calibration. If calibration fails, in the PCMCIA service application use the Vent diagnostics to check the transducer precision. Use the Flow valve control to compare linearity of the Manifold transducer to the Paw transducer.					
POWER CONTROLER COM FAIL	Internal failure. System may shut down	Communications with PC and DC cannot be established for ten seconds.	Medium	DC	
Reboot system. If problem continues: 1. Check DU cable connections. 2. Check the Display Connector board cable connections. 3. Replace the Power Controller board.					
POWER SUPPLY 75C	Circuitry >75C shutdown possible	Power supply temperature exceeds 75C	Medium	PC	
Check / Clean cooling fan.					
PWR CNTRL DC-DC FAIL	Using battery. PC fail	AC supply is OK (AC GOOD HIGH) but the system reports using the battery (BATT STAT 1 and 2 LOW)	Medium	PC	
Reboot system. If problem continues, replace the Power Controller Board.					

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
<b>Action/Troubleshooting</b>					
REVERSE EXPIRATORY FLOW	Reverse exp flow. Check valves OK?	Flow towards the patient (volume >= 20 mL) on expiratory sensor and flow towards the patient (volume >= 5 mL) on the inspiratory sensor during inspiration for 6 consecutive mechanical breaths	Medium	AC Vent	In-range flow data available, mechanical ventilation on
Check flow sensor connections for "No Flow Sensor" alarm. Check the breathing circuit. Perform flow sensor calibration. Check Insp/Exp check valves. Replace the flow sensors. Check for kinked VIB tubing. Check the VIB cabling.					
SCGO	Vol and Apnea monitoring off	Non Circle SCGO selected	Low	DC	System has SCGO
No service action required.					
STANDBY PATIENT DETECTION	No fresh gas flow!	3 volume breaths are detected within 30 seconds or 3 CO <sub>2</sub> breaths are detected within 30 seconds	High	DC	System in Checkout: General or Checkout: Start Case
No service action required.					
VENT FLOW VALVE FAIL DAC	Vent Fail. Monitoring Only	Incorrect DAC feedback for 3 consecutive readings	Medium	AC, Vent	
Reboot System. If problem continues, in the Service Software / Vent Flow & Pressure Diagnosis, increase the Flow Valve counts and view the Flow Valve Feedback mV and Counts. Verify the settings match.					
VENT +12.5V FAIL	Vent Fail. Monitoring Only	Nominal 12.5V <11.3 Vdc or >13.13 Vdc	Medium	AC, Vent	
In the Service Software / Vent Interface Bd Power Diagnosis, view the "Vent Int Bd 10VA Voltage" from Board Supplies: If "Vent Int Bd 10VA Voltage" reads "OK", and +12.5 Vdc reads "Fail", replace the VIB. If "Vent Int Bd 10VA Voltage" reads "Fail" and the "Vent Int Bd 10VA Voltage" from the Anes Cntrl Bd reads "OK", Check cabling between ACB and VIB.					

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
<b>Action/Troubleshooting</b>					
VENT +6V FAIL	Vent Fail. Monitoring Only	VSIB +6V out of range<5.51 Vdc or > 6.5 Vdc	High	AC, Vent	Vent +12.5 V (10 VA) is OK
In the Service Software / Vent Interface Bd Power Diagnosis, view the "Vent Int Bd 10VA Voltage" from Board Supplies: If "Vent Int Bd 10VA Voltage" reads "OK, and +6.0Vdc reads "Fail", replace the VIB. If "Vent Int Bd 10VA Voltage" reads "Fail" and the "Vent Int Bd 10VA Voltage" from the Anes Cntrl Bd reads "OK", Check cabling between ACB and VIB.					
VENT 1.22V FAIL	Vent Fail. Monitoring Only	Voltage < 1.074Vdc or Voltage > 1.367 Vdc	Medium	AC, Vent	Vent +12.5 V (10 VA) is OK
In the Service Software / Vent Interface Bd Power Diagnosis, view the "Vent Int Bd 10VA Voltage" from Board Supplies: If "Vent Int Bd 10VA Voltage" reads "OK, and 1.22 Vdc reads "Fail", replace the VIB. If "Vent Int Bd 10VA Voltage" reads "Fail" and the "Vent Int Bd 10VA Voltage" from the Anes Cntrl Bd reads "OK", Check cabling between ACB and VIB					
VENT -6V FAIL	Vent Fail. Monitoring Only	VSIB -6V out of range<-6.72 Vdc or >-5.28 Vdc	High	AC, Vent	Vent +12.5 V (10 VA) is OK
In the Service Software / Vent Interface Bd Power Diagnosis, view the "Vent Int Bd 10VA Voltage" from Board Supplies: If "Vent Int Bd 10VA Voltage" reads "OK, and -6.0Vdc reads "Fail", replace the VIB. If "Vent Int Bd 10VA Voltage" reads "Fail" and the "Vent Int Bd 10VA Voltage" from the Anes Cntrl Bd reads "OK", Check cabling between ACB and VIB.					
VENT ADC VREF FAIL	Vent Fail. Monitoring Only	VSIB ADC3.200V ref voltage out of range <3.179 or >3.221 Vdc	High	AC, Vent	Vent +12.5 V (10 VA) is OK
In the Service Software / Vent Interface Bd Power Diagnosis, view the "Vent Int Bd 10VA Voltage" from Board Supplies: If "Vent Int Bd 10VA Voltage" reads "OK, and 3.2 Vdc reads "Fail", replace the VIB. If "Vent Int Bd 10VA Voltage" reads "Fail" and the "Vent Int Bd 10VA Voltage" from the Anes Cntrl Bd reads "OK", Check cabling between ACB and VIB.					
VENT AIRWAY OVERPRESS SIGNAL	Inspiration stopped	High airway overpressure signal set.	Medium	AC, Vent	Mechanical Ventilation On
No Service Action. Reboot system. If problem continues, check Airway Pressure signal in Service Mode.					
VENT AIRWAY OVERPRESS SIGNAL FAIL	Vent Fail. Monitoring Only	Ventilator SIB indicates the High Airway overpressure signal was set and Paw < 90 cmH <sub>2</sub> O and Pmanifold <80 cm H <sub>2</sub> O.	Medium	AC, Vent	Mechanical Ventilation On
No Service Action. Reboot system. If problem continues, check Airway Pressure signal in Service Mode.					
VENT FLOW VALVE FAIL CURRENT	Vent Fail. Monitoring Only	Incorrect current feedback for 7 consecutive readings	Medium	AC, Vent	
Reboot System. If problem continues, in the Service Software / Vent Flow & Pressure Diagnosis, increase the Flow Valve counts and view the Flow Valve Current mA and Counts.					
VENT SUSTAINED PAW SDOWN	Vent Fail. Monitoring Only	Paw > 100 cmH <sub>2</sub> O for 10 seconds	Medium	AC, Vent	In-range Paw data available
No Service Action. Reboot system. If problem continues, check Airway Pressure signal in Service Mode.					

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
<b>Action/Troubleshooting</b>					
VENT VALVE POWER FAIL	Vent Fail. Monitoring Only	Nominal 12.5V <11.3 V or >13.13Vdc	Medium	AC, Vent	

In the Service Software / Vent Interface Bd Power Diagnosis, view the “Vent Int Bd 10VA Voltage” from Board Supplies:  
If “Vent Int Bd 10VA Voltage” reads “OK”, and the Vent Valve 10VA Volts reads “Fail”, disconnect the VIB to Pan connector harness. If the Vent Valve 10VA Volts continues to read “Fail”, replace the VIB.  
If “Vent Int Bd 10VA Voltage” reads “Fail” and the “Vent Int Bd 10VA Voltage” from the Anes Cntrl Bd reads “OK”, Check cabling between ACB and VIB.

## 7.4 Steps and Messages displayed during the System Checkout

### 7.4.1 Steps for the Quick Check

Step1: Check to make sure bag/vent switch is set correctly.

- If switch is set to manual mode continue with the next step.
- If set to ventilator mode fail with, “Wrong circuit selected”.

Step2: Is O<sub>2</sub> available and working?

- If O<sub>2</sub> Supply is Not low and mixer passes a mixer flow test of 250 ml/min of O<sub>2</sub> continue with the next step.
- If not fail with “Low O<sub>2</sub> supply pressure” or with mixer failure.

Step3: Is circuit (airway) pressure too high?

- Check the circuit (airway) pressure is less than 30 cm H<sub>2</sub>O; continue with the next step.
- If airway pressure greater than 30 cm H<sub>2</sub>O fail with “Circuit pressure too high”.
- Step4: Find manual circuit leak:
- Increase flow to find the manual circuit leak.
- If pressure does not increase to 30 cm H<sub>2</sub>O fail with “Cannot pressurize circuit”.
- If flow required to maintain pressure at 30 cm H<sub>2</sub>O is greater than 250 ml/min state “Manual circuit leak is XXX ml/min at 30 cm H<sub>2</sub>O” .
- If flow required to maintain pressure at 30 cm H<sub>2</sub>O is less than or equal to 250 cm H<sub>2</sub>O continue with the next step.

Step 5: Run mixer tests on the O<sub>2</sub> channel (check supply and run a 3L, 10L and leak test):

- If O<sub>2</sub> pressure is low, fail with “Low O<sub>2</sub> Supply pressure”.
- If mixer does not fail the 3L,10L and the leak test, continue with the next step.
- If mixer fails the 3L,10L or the leak test, fail with the mixer failure.

Step 6: Run mixer tests on the Air channel (check supply and run a 3L, 10L and leak test):

- If O<sub>2</sub> is drive gas and air supply is low, continue with next step and indicate, “Could not test air” .
- If Air is the drive gas and air supply is low, continue with next step and indicate, “Ventilator has not drive gas”.
- If mixer does not fail the 3L,10L and the leak test, continue with the next step. If mixer fails the 3L,10L or the leak test, fail with the mixer failure.

Step 7: Run mixer tests on the N<sub>2</sub>O channel (check supply and run a 3L, 10L and leak test):

- If N<sub>2</sub>O is disabled, continue with next step.
- If N<sub>2</sub>O supply is low, continue with next step and indicate, “Could not test N<sub>2</sub>O”.
- If mixer does not fail the 3L,10L and the leak test, continue with the next step.
- If mixer fails the 3L,10L or the leak test, fail with the mixer failure.

Step 8: Are the AC/Mains connected and the battery charged?

- If AC/Mains failed indicate, “Power cord disconnected. Using battery”.
- If Battery failed indicate, “Battery failure”.
- If Battery charging with 20 - 30 minutes available indicate, “Battery still charging.”
- If Battery charging with 10 - 20 minutes available indicate, “Battery still charging”.
- If battery charging with 0-10 minutes available indicate, “Battery still charging”.
- If battery fully charged, pass step.

## 7.4.2 Steps for the Vent Check

### Stage 1:

Step 1: Check to make sure bag/vent switch is set correctly.

- If switch is set to ventilator continue with the next step.
- If set to manual mode fail with “Wrong Circuit Selected”.

Step 2: Is O<sub>2</sub> Pressure Not Low?

- If O<sub>2</sub> Supply is Not low and mixer passes it's 3 L test continue to next step.
- If not fail with “Low O<sub>2</sub> supply pressure” or with mixer failure.

Step 3: Make sure ventilator has drive gas pressure:

- If drive gas pressure continue with the next step.
- If no drive gas pressure, fail with “Ventilator has no drive gas”.
- If all of the steps above pass, the ventilator will be commanded to flow 12 L/min. Depending on the software you have a 10 second delay may be in place before the next menu is displayed. Either way before selecting “Continue” on the next menu, “Make sure the bellows are fully collapsed” before you “Occlude the Patient Y”.

### Stage 2:

Step 1: Check to make sure bellows are collapsed.

- If Airway pressure increases to or above 30 cm H<sub>2</sub>O in 5 seconds fail the test with, “Can not empty bellows”.
- If not continue with next step.

Step 2: Attempt to find the leak of the ventilator mode system.

- Flow 1 l/min O<sub>2</sub> until pressure increases to 20 cm H<sub>2</sub>O.
- If pressure does not increase to 20 cm H<sub>2</sub>O within in 15 seconds, fail with “Cannot pressurize circuit”. If it does reach 20 cm H<sub>2</sub>O, change flow to 250 ml/min.
- If a flow of 250 ml/min reaches 30 cm H<sub>2</sub>O or greater continue to next step. If it does not, increase flow up to 750 ml/min.
- If a flow is found that reaches 30 cm H<sub>2</sub>O and that flow is less than 750 ml/min continue to next step but indicate that, “Ventilator circuit leak is ## ml/min”.
- If a flow greater than 750 ml/min is required, fail with, “Ventilator circuit leak is greater than 750 ml/min”.

Step 3: System delivers small breaths and looks for alarms using default alarm limits.

- If alarm condition is detected it will be stated in final menu.
- Continue to next step.

Step 4: Calculate circuit compliance.

- If alarms occurred that prohibit the calculation of circuit compliance, state that “Can not measure circuit compliance”.
- If alarms did not occur then calculate compliance and state, “Circuit Compliance YYY ml/ cm H<sub>2</sub>O”

S/5 Avance

# 8 Service Diagnostics and Software Download

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## 8.1 Avance Service Application

This section documents the Avance Service Application that loads from a PCMCIA card and is used to download software or to run various diagnostic functions.

To run the application, first set the system switch to Standby and set the AC Inlet power switch to Off. Insert the card carrier (with card facing to the rear) into the rear PCMCIA interface slot of the display unit (behind left side door), then set the AC Inlet power switch and the system switch to On. The service application will load and display the Main Menu along with the System Information page.

### 8.1.1 Main Menu and System Information

The Main Menu appears on the left-hand side of the screen and includes the following selections as shown in the table below:

Main Menu	Remarks
Power Diagnostics	Access to the Power Supply Diagnostics functions
Gas Diagnostics	Access to the Gas Delivery Diagnostics functions
Vent Diagnostics	Access to the Ventilator Diagnostics functions
Display Diagnostics	Access to the Front Panel Controls
Special Functions	Access to logs from the Display Unit
<hr/>	
Software Download	Access to the Software Download function.

**Note** You can not return to the Diagnostic section of the service application after entering the software download section. You must reboot the system to exit Software Download.

The System Information page appears on the right-hand side of the screen and displays the following system information as shown in the table below:

#### System Information

Subsystem	HW Rev	Serial #	SW Ver #	Boot
Front Panel Cntl	---	---	XX.XX	
Power Controller	XXX/A/XXX	ABCXXXX	XX.XX	XX.XX
Electronic Mixer	XXX/A/XXX	ABCXXXX	XX.XX	XX.XX
Vent Intface Bd	XXX/A/XXX	ABCXXXX	XX.XX	XX.XX
Anes Control Bd	XXX/A/XXX	ABCXXXX	XX.XX	XX.XX
Dsply Unit BIOS	XXX/A/XXX	ABCXXXX	XX.XX	
Dsply Unit App	XXX/A/XXX	ABCXXXX	XX.XX	
 Machine Serial Number: ABCDXXXX				
PC Card ID: XXXX_XX				

### 8.1.2 Power Diagnostics

The service application provides power supply diagnostics for the various circuit boards in the Avance anesthesia machine.

Selecting **Power Diagnostics** on the Main Menu brings up the following menu selections in the left-hand frame and the instructions in the right-hand frame:

Main Menu	Power Diagnostics	Power Controller Power Diagnostics
Power Diagnostics Gas Diagnostics Vent Diagnostics Display Diagnostics Special Functions ----- Software Download	Power Control Anes Control Board Mixer Vent Interface Bd Display Unit -> Main Menu	Select a menu item to see the power status and measured voltages.  To troubleshoot a power problem, start with the power controller and work forward. Problem voltages are in red.

### 8.1.3 Power Controller Power Diagnostics

There are two pages of diagnostics for the Power Controller.

Selecting **Power Control** brings up the first page of the Power Controller Diagnostics.

Power Diagnostics	
	Power Control
	Anes Control Board
	Mixer
	Vent Interface Bd
	Display Unit
	->Main Menu

Label	Value Format	Units	Normal range
AC Status	OK, Fail		
12Vdc Supply	XX.XX	Vdc	11.82 to 12.18
3.3Vdc Supply	X.XXX	Vdc	3.201 to 3.399
1.5 Vdc Supply	X.XXX	Vdc	1.45 to 1.55
Battery Connected	Yes, No		
Battery Status	Fail, Bulk Chg, Over Chg, Float Chg, Trickle Chg, Discharge		
Battery Current	X.XXX	A	
Calc Battery Time	XX	Min	0 to 30
Battery 1 Volts	XX.X < 6.0 FAIL (red) <10 T Chg (yellow) 10-15.5 (Green)	Vdc	10.0 to 15.5
Battery 2 Volts	XX.X < 6.0 FAIL (red) <10 T Chg (yellow) 10-15.5 (Green)	Vdc	10.0 to 15.5
Date battery Tested	XX-ABC-XXXX		
Last Full Discharge Time	XX	Min	

Turn the ComWheel to select the second page.

Push the ComWheel to return focus to the Power Diagnostics selection menu.

**(Page 2 of 2)**  
**Power Control Power Diagnostics**

<b>Power Diagnostics</b>
Power Control
Anes Control Board
Mixer
Vent Interface Bd
Display Unit
->Main Menu

<b>Label</b>	<b>Value Format</b>	<b>Units</b>	<b>Normal range</b>
Board Temperature	<65C OK (green) >65C <75C Warn (Yellow) >75C Fail (red)	Deg C	Upper 64
Fan Speed	Slow, Fast		
Fan 1 Voltage	XX.XX	Vdc	11.52 to 12.48
Fan 1 Status	Low, High, Fail, OK		

Turn the ComWheel to return to the first page.

Push the ComWheel to return focus to the Power Diagnostics selection menu.

## 8.1.4 Anesthesia Control Board Power Diagnostics

There are two pages of diagnostics for the Anesthesia Control board.

Selecting **Anes Control Board** brings up the first page of the Anesthesia Control Board Power Diagnostics.

Power Diagnostics
Power Control
<b>Anes Control Board</b>
Mixer
Vent Interface Bd
Display Unit
->Main Menu

Label	Value Format	Units	Normal range
12.5Vdc from Pwr Cntrl	XX.XX	Vdc	11.90 to 12.90
ADC Reference	X.XXX	Vdc	4.018 to 4.176
Gas Select 10VA Volts	OK, Fail		
Gas Select 10VA Amps	OK, Fail		
P Xducer 10VA Amps	OK, Fail		
Vent Int Bd 10VA Volts	OK, Fail		
Vent Int Bd 10VA Amps	OK, Fail		
Vent Valves 10VA Volts	OK, Fail		
Vent Valves 10VA Amps	OK, Fail		
Acces 1 10VA Volts	OK, Fail		
Acces 1 10VA Amps	OK, Fail		

Turn the ComWheel to select the second page.

Push the ComWheel to return focus to the Power Diagnostics selection menu.

**(Page 2 of 2)**  
**Anes Control Board Power Diagnostics**

<b>Power Diagnostics</b>	
Power Control	
Anes Control Board	
Mixer	
Vent Interface Bd	
Display Unit	
->Main Menu	

<b>Label</b>	<b>Value Format</b>
Gas Unit 10VA Volts	OK, Fail
Gas Unit 10VA Amps	OK, Fail
Mixer 10VA Volts	OK, Fail
Mixer 10VA Amps	OK, Fail
Alt O2 10VA Volts	OK, Fail
Alt O2 10VA Amps	OK, Fail
Periph1 10VA Volts	OK, Fail
Periph1 10VA Amps	OK, Fail
Periph2 10VA Volts	OK, Fail
Periph2 10VA Amps	OK, Fail

Turn the ComWheel to return to the first page.

Push the ComWheel to return focus to the Power Diagnostics selection menu.

## 8.1.5 Electronic Mixer Power Diagnostics

Selecting **Mixer** brings up the Electronic Mixer Power Diagnostics page.

Power Diagnostics
Power Control
Anes Control Board
<b>Mixer</b>
Vent Interface Bd
Display Unit
->Main Menu

Label	Value Format	Units	Normal range
<b>From Anes Cntrl Bd</b>			
Mixer 10VA Volts	OK, Fail		
<b>Board Supplies</b>			
12.5 V	XX.XX	Vdc	11.80 to 13.00
5.5V	X.XX	Vdc	5.39 to 5.61
3.3V CPU	X.XX	Vdc	3.22 to 3.38
2.5V ADC Ref	X.XX	Vdc	2.47 to 2.53

## 8.1.6 Ventilator Interface Board Power Diagnostics

Selecting **Vent Interface Board** brings up the Ventilator Interface Board Power Diagnostics page.

### Vent Interface Bd Power Diagnostics

Power Diagnostics
Power Control
Anes Control Board
Mixer
<b>Vent Interface Bd</b>
Display Unit
->Main Menu

Label	Value Format	Units	Normal range
<b>From Anes Cntrl Bd</b>			
Vent Int Bd 10VA Volts	OK, Fail		
Vent Valves 10VA Volts	OK, Fail		
<b>Board Supplies</b>			
Vent Int Bd 10VA Volts	XX.XX	Vdc	11.30 to 13.13
Vent Valves 10VA Volts	XX.XX	Vdc	11.30 to 13.13
3.2Vdc (12bit Vref)	X.XXX XXXX	Vdc Counts	3.179 to 3.221
1.22Vdc (10bit Vref)	X.XXX XXXX	Vdc Counts	1.074 to 1.367
+6.0Vdc	X.XX	Vdc	5.51 to 6.50
-6.0Vdc	-X.XX	Vdc	-6.72 to -5.28

## 8.1.7 Display Unit Power Diagnostics

Selecting **Display Unit** brings up the Display Unit Power Diagnostics page.

**Display Unit Power Diagnostics**

Power Diagnostics	Label	Value Format	Units	Normal range
Power Control	5.0Vdc (PCMCIA)	X.XX	Vdc	4.50 to 5.50
Anes Control Board	3.3Vdc (PCMCIA)	X.XX	Vdc	2.97 to 3.63
Mixer	5.0Vdc (Fan)	X.XX	Vdc	4.50 to 5.50
Vent Interface Bd	5.0Vdc (USB)	X.XX	Vdc	4.50 to 5.50
<b>Display Unit</b>	8.0Vdc (DIS)	X.XX	Vdc	7.20 to 8.80
->Main Menu	11Vdc (LCD)	XX.XX	Vdc	10.35 to 13.62

## 8.2 Gas Diagnostics

Selecting **Gas Diagnostics** on the Main Menu brings up the following menu selections in the left-hand frame and the instructions in the right-hand frame.

Main Menu	Gas Diagnostics	Gas Diagnostics
Power Diagnostics <b>Gas Diagnostics</b> Vent Diagnostics Display Diagnostics ----- Software Download	Gas Supplies Mixer Output Mixer Tests and Pres Mixer Temperatures O2 Flow: OFF N2O Flow: OFF Air Flow OFF Breathing Sys Leak -> Main Menu	To troubleshoot a problem with gas supplies or gas flows, start with the gas supplies menu and work forward.  To turn on gas flows, select O2, N2O, or Air in the left menu.  Available flows are: 100% O2: 0.2, 0.5, 5, 10 l/min 100% N2O: 0.2, 0.5, 5, 10 l/min Air: 0.2, 0.5, 5, 10 l/min  Turning ON a different gas automatically turns OFF previous flows. All gas flows stop if you go back to the main menu.

Selecting any of the first four items in the left-hand frame, brings up the corresponding diagnostic page in the right-hand frame.

Press the ComWheel to return focus to the right-hand frame to make another selection.

### Start gas flow

Selecting one of the three gas flows brings up a page on which you can set one of the four flow values for the selected gas:

- 0.2 l/min; 0.5 l/min, 5.0 l/min, 10.0 l/min.

Press the ComWheel to start the selected flow.

Press the ComWheel again to return to the flow page to observe the Airway Pressure reading. Or select one of the four diagnostics pages to view the displayed conditions.

Selecting Breathing Sys Leak, opens the GIV valve and sets a flow through the inspiratory flow valve. While on the Breathing Sys Leak page, you can set O2 flow to the breathing system and observe the Airway Pressure reading.

### Stop gas flow

Gas will continue to flow at the set rate until you:

- set a different flow for the same gas,
- set a flow for a different gas (automatically turns the previous gas flow OFF),
- set the current gas flow to OFF (all flows OFF),
- exit Gas Diagnostics to the Main Menu.

## 8.2.1 Gas Supplies

Each gas supply shows the derived pressure in kPa and psi along with the raw voltage from the pressure transducer.

If a supply module for a gas is not installed, or if the transducer is disconnected, the supply shows 0.00 Vdc.

If a supply module is installed but no supply is connected, the supply shows approximately 0.50 Vdc.

The remaining items show the state of the Electronic Mixer selector valves.

### Gas Supplies Gas Diagnostics

<b>Gas Diagnostics</b>			
	<b>Label</b>	<b>psi</b>	<b>kPa</b>
			<b>Vdc</b>
Gas Supplies	O2 Cylinder 1	XXXX	XXXXX
	O2 Cylinder 2	XXXX	XXXXX
Mixer Output	Air Cylinder	XXXX	XXXXX
Mixer Tests and Pres	N2O Cylinder	XXXX	XXXXX
Mixer Temperatures	O2 Pipeline	XXXX	XXXXX
O2 Flow: 0.5	Air Pipeline	XXXX	XXXXX
N2O Flow: OFF	N2O Pipeline	XXXX	XXXXX
Air Flow: OFF	O2 Select Valve	Open	Flow command ON
Breathing Sys Leak	N2O Select Valve	Closed	Flow command OFF
-> Main Menu	Air Select Valve	Closed	Flow command OFF
	Alt O2 Valve	Closed	
Note: 0.0 Vdc = not installed or transducer disconnected.			

## 8.2.2 Mixer Output

Selecting **Mixer Output** brings up the Mixer Output Gas Diagnostics page.

This data comes from the Anesthesia Control board. The Flow Verify signals are rough calculations of the mixer flow based on pressure drop and temperature. The ADC reference voltage is used to convert flow signals.

### Mixer Output Gas Diagnostics

<b>Gas Diagnostics</b>		
<b>Label</b>	<b>Value</b>	<b>Units</b>
Gas Supplies		
Mixer Output		
Mixer Tests and Pres		
Mixer Temperatures		
O2 Flow: 0.5	XX.XX	l/min
N2O Flow: OFF	XX.XX	l/min
Air Flow: OFF	X.XXX	Vdc
Breathing Sys Leak	XXXX	mA
-> Main Menu		
Balance Gas ID	None, Air, N2O	
Balance Flow Verify	XX.XX	l/min
Balance Flow Signal	X.XXX	Vdc
Balance Prop Valve Drive	XXXX	mA
O2 Select Valve	Open	
Air Select Valve	Closed	
N2O Select Valve	Closed	
ADC Ref Voltage	X.XXX	Vdc

### 8.2.3 Mixer Tests and Pressure

Selecting **Mixer Tests and Pres** brings up the Mixer Tests and Pres Gas Delivery Diagnostics page.

#### Mixer Tests and Pres Gas Diagnostics

<b>Gas Diagnostics</b>			
Gas Supplies	O2 Proportional Valve Leak	Not done. No supply pressure	
Mixer Output		Not done. Selector valve incorrect state	
<b>Mixer Tests and Pres</b>		Pass	
Mixer Temperatures		Fail. Selector valve leaks	
O2 Flow: 0.5		Fail. Proportional valve leaks	
N2O Flow: OFF	Alt O2 Valve Leak	Pass; Fail	
Air Flow: OFF	Balance Gas Prop Valve Leak	Not done. No supply pressure	
Breathing Sys Leak		Not done. Selector valve incorrect state	
-> Main Menu		Pass	
	Balance Gas CheckValve Leak	Fail. Selector valve leaks	
	O2 Flow Test	Fail. Proportional valve leaks	
		Not done. No supply pressure;	
		Not done. Selector valve incorrect state;	
		Pass;	
		Fail, 3 l/min test;	
		Fail, 10 l/min test	
	Balance Flow Test	Not done. No supply pressure;	
		Not done. Selector valve incorrect state;	
		Pass;	
		Fail, 3 l/min test;	
		Fail, 10 l/min test	
	Balance Gas ID	None; Air; N2O	
<b>Pressure Data</b>			
	<b>Value</b>	<b>Units</b>	<b>kPa</b>
O2 Pressure (P1)	XX.XX	psi	XXX.XX
O2 Pres Cal (P1)	X.XXX	Vdc	
Balance Pressure (P2)	XX.XX	psi	XXX.XX
Balance Pres Cal (P2)	X.XXX	Vdc	
Mixer Output Pres (P3)	XX.XX	psi	XXX.XX
Mixer Output Pres Cal (P3)	X.XXX	Vdc	
ADC Ref Voltage	X.XXX	Vdc	

### 8.2.4 Mixer Temperature

Selecting **Mixer Temperatures** brings up the Mixer Temperatures Gas Diagnostics page.

#### Mixer Temperatures Gas Diagnostics

Gas Diagnostics		
Sensor Data	Value	Units
O2 Temp (T1)	XX.X	Deg C
O2 Temp Volts (T1)	X.XXX	Vdc
Balance Temp (T2)	XX.X	Deg C
Balance Temp Volts (T2)	X.XXX	Vdc
ADC Ref Voltage	X.XXX	Vdc

### 8.2.5 Setting Gas Flow

Selecting **O2 Flow: OFF** brings up the O2 Flow Setting page on which you can select one of four flows (or OFF if flow previously set):

- 0.2 l/min
- 0.5 l/min
- 5.0 l/min
- 10.0 l/min

Selecting “N2O Flow: OFF” or “Air Flow: OFF” brings up a comparable page for setting the above flows for the selected gas. Selecting a flow for a new gas turns the previous gas flow to OFF.

#### 02 Flow Setting

<b>Gas Diagnostics</b>		
	<b>Value</b>	<b>Units</b>
Gas Supplies	X.X	l/min
Mixer Output		
Mixer Tests and Pres		
Mixer Temperatures		
<b>O2 Flow: OFF</b>		
N2O Flow: OFF		
Air Flow: OFF		
Breathing Sys Leak		
-> Main Menu		

To choose a gas flow, turn ComWheel.  
Gas flows do not change until you push ComWheel.

Airway pressure: XXX cmH20

Push ComWheel to Exit and start O2 flow ->

After setting a gas flow, push the ComWheel again to return to the Flow Setting page to observe the Airway Pressure reading, or select one of the four diagnostics pages to view the displayed conditions.

All gas flow stops when you exit Gas Diagnostics to the Main Menu.

## 8.2.6 Breathing System Leak Test

Selecting **Breathing Sys Leak** brings up the Breathing Sys Leak page.

Entering the Breathing Sys Leak page, opens the Gas Inlet Valve and sets up a constant flow through the Inspiratory Flow Valve.

On the Breathing Sys Leak page you can set an O2 flow through the Gas Mixer and view the Airway Pressure.

### Breathing Sys Leak

Gas Diagnostics	
Gas Supplies	
Mixer Output	
Mixer Tests and Pres	
Mixer Temperatures	
O2 Flow: OFF	
N2O Flow: OFF	
Air Flow: OFF	
<b>Breathing Sys Leak</b>	
-> Main Menu	

Breathing Sys Leak		
	Value	Units
O2 Flow	X.X	l/min
To choose a gas flow, turn ComWheel.		
Gas flows do not change until you push ComWheel.		
Refer to Technical Reference Manual for this procedure.		
Airway pressure: XXX cmH2O		
Second ComWheel Push Ends Test ->		

All gas flow stops when you exit Gas Diagnostics to the Main Menu.

**Note** This procedure is detailed in Test 6, “Testing the bellows module and the Bag/Vent switch” on page 7-17.

## 8.3 Ventilation Diagnostics

The service application provides several pages for ventilation diagnostics.

Selecting **Vent Diagnostics** on the Main Menu brings up the following menu selections in the left-hand frame and the instructions in the right-hand frame:

Main Menu	Vent Diagnostics	Vent Diagnostics
Power Diagnostics	Status	Status data shows the position of breathing circuit switches.
Gas Diagnostics	Vent Flow and Pres	Vent Flow and Pres shows vent sensor readings.
Vent Diagnostics	Gas Inlet Vlv ON/OFF	Other commands in the menu column let you control ventilator valves and send gas to either the circle or the non-circle circuit.
Display Diagnostics	Flow Valve Control	
Special Functions	Toggle Circuit	
-----	-> Main Menu	
Software Download		

Vent Diagnostics	Action when selected
Status	Selecting <b>Status</b> displays the Ventilation Status page.
Vent Flow and Pres	Selecting <b>Vent Flow and Pres</b> displays the Ventilation Flow and Pressure page.
Gas Inlet Vlv ON/OFF	Selecting <b>Gas Inlet Vlv ON/OFF</b> toggles the Gas Inlet Valve to the Open or Closed position and sets the right-hand screen to the Vent Flow and Pressure Diagnostics page.
Flow Valve Control	Selecting <b>Flow Valve Control</b> sets the right-hand screen to the Vent Flow and Pressure Diagnostics page and allows the user to increase or decrease the DAC count to the flow valve using the ComWheel.
Toggle Circuit	Selecting <b>Toggle Circuit</b> toggles between commanding Circle or Non-Circle for the SCGO valve and sets the right-hand screen to the Vent Status page (does not apply to machines with ACGO).
->Main Menu	Selecting <b>Main Menu</b> closes the Gas Inlet Valve and the Flow Valve and return to the Main Menu.

The actions of the Gas Inlet, the Flow Valve Control, and the Circuit selection are reflected on both the Ventilation Status page and the Ventilation Flow and Pressure page.

The Gas Inlet Valve must be in the ON position in order for gas to flow.

**8.3.1 Status**

Selecting **Status** brings up the Ventilation Status page.

Vent Diagnostics	
	Status
	Vent Flow and Pres
	Gas Inlet Vlv ON/OFF
	Flow Valve Control
	Toggle Circuit
->	Main Menu

Menu Item	Value	Units
Gas Inlet Valve	Open or Closed	
Flow Valve	XXXX	Counts
Circuit Command	Circle or Non-Circle	
Vent Drive Gas	Air or O2	
ABS Installed	Yes or No	
Flush Valve	Not Pressed or Pressed	
O2 Cell Status	Connected or None	
Bag/Vent Switch	Bag or Vent	
Circuit Feedback	Circle, Non-Circle, or Fault	
ACGO/SCGO Configuration	ACGO or SCGO	
Over Pressure Circuit	OK or High Pressure	
Gas Inlet Valve Feedback	Open or Closed	

### 8.3.2 Vent Flow and Pressure

Selecting **Vent Flow and Pres** brings up the Ventilation Flow and Pressure page.

#### Vent Flow and Pressure Diagnostics

Vent Diagnostics	
Status	
Vent Flow and Pres	
Gas Inlet Vlv ON/OFF	
Flow Valve Control	
Toggle Circuit	
-> Main Menu	

Menu Item	Value	Units	Value	Units
Gas Inlet Valve	Open or Closed			
Flow Valve	XXXX	Counts		
	Turn ComWheel to adjust flow valve	(appears when Flow Valve Control set ON)		
Circuit Command	Circle or Non-Circle			
Inspiratory Flow	XXX.X	l/min	XXXX	Counts
Expiratory Flow	XXX.X	l/min	XXXX	Counts
Airway Pressure	XXX	cmH2O	XXXX	Counts
Manifold Pressure	XXX	cmH2O	XXXX	Counts
O2 Cell	XXX	%	XXXX	Counts
ADC Ref Voltage	X.XXX	Vdc		
Flow Valve Setting	XXX.X	l/min	XXXX	Counts
Flow Valve Feedback	xxxx	mV	XXXX	Counts
Flow Valve Current	xxxx	mA	XXXX	Counts

## 8.4 Display Diagnostics

The service application provides several pages for display diagnostics.

Selecting **Display Diagnostics** on the Main Menu brings up the following menu selections in the left-hand frame:

Main Menu
Power Diagnostics
Gas Diagnostics
Vent Diagnostics
<b>Display Diagnostics</b>
Special Functions
-----
Software Download

Display Diagnostics	Display Diagnostics Instructions
Test LEDs Test Speaker Test Backlight 1 Test Backlight 2 Test Keys -> Main Menu	Select a menu item  To troubleshoot a display problem, start with Test LEDs and work forward

Display Diagnostics	Action when selected
Test LEDs	Selecting <b>Test LEDs</b> causes the red and yellow LEDS next to the <b>Silence Alarms</b> key to flash for 10 seconds.
Test Speaker	Selecting <b>Test Speaker</b> causes the speaker to sound for 5 seconds.
Test Backlight 1	Selecting <b>Test Backlight 1</b> turns backlight 2 off for 10 seconds. "If screen goes black during test, a backlight is out."
Test Backlight 2	Selecting <b>Test Backlight 2</b> turns backlight 1 off for 10 seconds. "If screen goes black during test, a backlight is out."
Test Keys	Selecting <b>Test Keys</b> brings up a representative display of the front panel controls. Pressing a softkey will cause the corresponding key text to be highlighted.
Main Menu	Selecting <b>Main Menu</b> returns to the Main Menu.

## 8.5 Special Functions

Selecting **Special Functions** on the Main Menu brings up the following menu selections in the left-hand frame:

Main Menu	Special Functions	Special Functions
Power Diagnostics Gas Diagnostics Vent Diagnostics Display Diagnostics <b>Special Functions</b> ----- Software Download	Mixer Service Menu View Error Log View Alarm Log View Event Log View Revision Log Compatibility Table PC Card Install Log View Install Errors -> Main Menu	

**Mixer Service Menu** Refer to section 8.5.1.

**Error, Alarm, Event Logs** In a functioning system, the Error, Alarm, and Event Logs are accessible on the system's Service Log menu (refer to Section 4.4.2). If a system comes up in a "Failed State", you can download the logs to the Service Application PC Card and view them on the Special Functions screen.

To download the logs, insert the Service Application PC Card into the Display Unit and press the "Help" softkey. Wait approximately 60 seconds while the logs are downloaded to the card (no apparent activity). Restart the system with the Service Application to view the logs.

**Revision and PC Card Install Logs** Whenever a Software Download is completed, the specific software download is recorded in the Revision Log that resides on the system (Display Unit) and in the PC Card Install Log that resides on the PC Card.

**Compatibility Table** The Compatibility Table lists the current software components that last downloaded on to the system. In essence, it is the latest listing that appears in the Revision Log, which allows you to view the current log directly without having to scroll to it.

### 8.5.1 Mixer Service Menu

Selecting **Mixer Service Menu** brings up the Mixer Service Instructions.

Mixer Service Menu	Mixer Service Instructions
Zero Pres Sensors Reset Defaults -> Special Functions	<p>Select Zero Pres Sensors to recalibrate the pressure sensor zero-offsets.</p> <p>Select Reset Defaults to restore factory default offsets.</p> <p>If you want to select Zero Pres Sensors . . .</p> <ol style="list-style-type: none"> <li>1) Disconnect gas supplies from system.</li> <li>2) Close cylinders.</li> <li>3) Confirm that all vaporizers are turned "OFF".</li> <li>4) Remove the flow sensor cover.</li> <li>5) Move the Bag-to-Vent switch to the Bag position.</li> <li>6) Press the O2 Flush button for 3 seconds.</li> <li>7) WAIT AT LEAST 5 MINUTES WITH NO GAS FLOWING.</li> <li>8) Select Zero Pres Sensors on the menu.</li> </ol> <p>If you want to select Zero Pres Sensors . . .</p> <p>DO NOT DISTURB THE SYSTEM WHILE WAITING FOR RESULTS.</p>

#### Zero mixer pressure sensors

Mixer Service Menu	Zero Pres Sensors
Zero Pres Sensors Reset Defaults -> Special Functions	<p>Pressure sensor zero-offset adjust requested.</p> <p>Note: this procedure will require at least 2 minutes.</p>

#### Reset factory default zero offsets

Mixer Service Menu	Zero Pres Sensors
Zero Pres Sensors Reset Defaults -> Special Functions	<p>Reset to Factory Defaults requested.</p>

## 8.5.2 View Revision Log

Selecting ***View Revisions Log*** brings up the Revision Log for the system. The log includes chronological entries for every Software Download that was completed to the system. Each entry includes two header lines and eight data lines in the following format:

<b>View Revision Log</b>
<pre># Software configuration after download on (day) (date) (time) # SvcApp Version (XX.XX), Machine Serial Number (ABCDXXXX) Avance ACB, (Stock Number) (RevX), (Software Level), (File Name) (Serial #) AnesControl B Avance MXR, (Stock Number) (RevX), (Software Level), (File Name) (Serial #) Electronic Mix Avance VNT, (Stock Number) (RevX), (Software Level), (File Name) (Serial #) Vent Intface B Avance FPC, *, (Software Level), (File Name) (#-----) Front Panel CN Avance PSC, (Stock Number) (RevX), (Software Level), (File Name) (Serial #) Power Controll Avance DUA, *, (Software Level), (File Name) (#-----) Dsply Unit App Avance DUB, (Stock Number) (RevX), (Software Level), (File Name) (Serial #) Dsply Unit BIO Avance DUF, *, (Software Level), (File Name) (#-----) Dsply Unit Fla</pre>

**Note** The Stock Number listed is for the board assembly and may not represent an orderable service item. Refer to the parts lists in Section 10 for service level stock numbers.

The Front Panel Control (FPC), Display Unit Application (DUA), and the Display Unit Flash (DUF) reside, along with the Display Unit BIOS (DUB), on the Display Unit CPU board.

## 8.5.3 View PC Card Install Log

Selecting ***View PC Card Install Log*** brings up the PC Card Install Log for the software download card. The log includes chronological entries for every Software Download that was completed with the card. Each entry includes two header lines and eight data lines in the following format:

<b>PC Card Install Log</b>
<pre>INSTALLATION LOG for PC Card # XXXXXX  # Software configuration after download on (day) (date) (time) # SvcApp Version (XX.XX), Machine Serial Number (ABCDXXXX), Card # XXXXXX/ Avance ACB, (Stock Number) (RevX), (Software Level), (File Name) (Serial #) AnesControl B Avance MXR, (Stock Number) (RevX), (Software Level), (File Name) (Serial #) Electronic Mix Avance VNT, (Stock Number) (RevX), (Software Level), (File Name) (Serial #) Vent Intface B Avance FPC, *, (Software Level), (File Name) (#-----) Front Panel CN Avance PSC, (Stock Number) (RevX), (Software Level), (File Name) (Serial #) Power Controll Avance DUA, *, (Software Level), (File Name) (#-----) Dsply Unit App Avance DUB, (Stock Number) (RevX), (Software Level), (File Name) (Serial #) Dsply Unit BIO Avance DUF, *, (Software Level), (File Name) (#-----) Dsply Unit Fla</pre>

## 8.6 Software Download

Selecting **Software Download** bring up the following information page:

Main Menu
Power Diagnostics
Gas Diagnostics
Vent Diagnostics
Display Diagnostics
Special Functions
-----
Software Download

ENTERING SOFTWARE DOWNLOAD MODE!
To return to Diagnostics: turn On/Standby switch to Standby, and turn off AC mains switch in rear. Wait 20 seconds, then turn on power with the AC mains switch and the On/Standby switch.
(Press ComWheel to continue with Download.)

**Note**

You can not return to the Diagnostic section of the service application after entering the software download section. You must reboot the system to exit Software Download.

Entering software download brings up the Software Download menu.

Software Download	Remarks
Download All	Downloads all software subsystems.
Download New	Downloads only new software versions not found on the system and compatible with installed subsystem hardware.

Since downloading all the subsystem software can take an hour or more, you should normally choose "Download New" to install only the updated subsystem software or software required for newly installed subsystems.

### Software Download Status

Software Download
Download All
Download New

Subsystem	HW Rev	Current SW Ver #	New SW Ver #	Status
Front Panel Cntl	XXX/A/XX	XX.XX	XX.XX	XXXXXX
Power Controller	XXX/A/XX	XX.XX	XX.XX	XXXXXX
Electronic Mixer	XXX/A/XX	XX.XX	XX.XX	XXXXXX
Vent Intfce Bd	XXX/A/XX	XX.XX	XX.XX	XXXXXX
Anes Control Brd	XXX/A/XX	XX.XX	XX.XX	XXXXXX
Dsply Unit BIOS	XXX/A/XX	XX.XX	XX.XX	XXXXXX
Dsply Unit Flash		---		XXXXXX
Dsply Unit App	XXX/A/XX	XX.XX	XX.XX	XXXXXX

Loading Xxxx Xxxxxxxxxx Xxxxx:  
\*\*\*\*\*

## Notes about downloading software

If there is no Front Panel Control software installed in the system (as would be the case when the display units control board is replaced), the Service Application automatically downloads the Front Panel Controls software at startup. During the download the two display unit LEDs will flash and the display speaker will sound an alarm tone to indicate that Software Download is proceeding. The display will be black until the automatic download is complete.
To ensure that all software versions on the system are compatible, the end result of "Download All" or "Download New" will be the same. The software loaded on the machine will exactly match what is on the card. Be sure to have the latest/correct version of software before attempting a download to avoid inadvertent overwrites of newer software with an older version.
If, during the "Download New" process, the compatibility checker detects a newer version of software component on the system, a "Notice" appears on the screen that asks you to confirm the downgrade.
"Download All" will download all compatible software from the card to the system without issuing a notice that newer version of software component may be on the system.

### Download process

The PCMCIA card includes only the latest software for each subsystem along with the diagnostic application.

As each subsystem software segment is being downloaded, the following status messages note the state of each subsystem and the result of the download:

- **Busy** - System is running its application code; not ready for download.
- **Ready** - System is in its boot code; ready for download.
- **CRCtest** - System is analyzing the download CRC.
- **Loading** - System is accepting download data.
- **Done** - Software download has completed successfully.
- **Fail** - Software download did not complete successfully. A "Fail" message will require reloading of the software; or repair of the system may be necessary.
- **Skipped** - Software download was bypassed.
- **Linked** - System is communicating, but status is not yet known.
- **Not Compatible** - The software version on the PCMCIA card is not compatible with the subsystem.

If the subsystem is communicating but the HW Rev or current SW Rev are not known, the message **Unknown** will appear under the columns for those values. If the HW Rev or current SW Rev are not known, the download function will still be available.

As the software loads, an activity bar at the bottom of the screen shows the download progress for each subsystem.

### Download complete

When all the required subsystem software is download, the following message appears on the screen. You must shut down the system to exit the download function.

DOWNLOAD IS COMPLETE. Remove PCMCIA card. Turn ON/STANBY switch to STANDBY. Turn OFF AC mains switch in rear.
------------------------------------------------------------------------------------------------------------------------

# 9 Repair Procedures

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- ⚠ WARNING** To prevent fires:
- Use lubricants approved for anesthesia or O<sub>2</sub> equipment, such as Krytox.
  - Do not use lubricants that contain oil or grease; they burn or explode in high O<sub>2</sub> concentrations.
  - All covers used on the system must be made from antistatic (conductive) materials. Static electricity can cause fires.
- ⚠** Obey infection control and safety procedures. Used equipment may contain blood and body fluids.
- ⚠** A movable part or a removable component may present a pinch or a crush hazard. Use care when moving or replacing system parts and components.
- ⚠** Some internal parts have sharp edges and can cause cuts or abrasions. Use care when servicing internal components.
- ⚠** After repairs are completed, always perform the checkout procedure. Refer to Section 3 of this manual.
- ⚠ CAUTION** Electrostatic discharge through circuit boards may damage the components on them. Wear a static control wrist strap before touching the circuit boards. Handle all circuit boards by their non-conductive edges. Use anti-static containers when transporting them.

## 9.1 How to bleed gas pressure from the machine

Before disconnecting pneumatic fittings, bleed all gas pressure from the machine.

1. Close all cylinder valves and disconnect all pipeline supplies from the source.
2. Set the system switch to On.
3. Ensure that all cylinder and pipeline pressures read zero.
4. Establish a flow for the affected gas to bleed down the pressure.
5. Set the system switch to Standby.

## 9.2 How to remove the rear panels

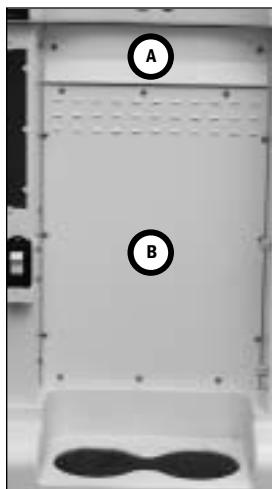
You must remove the rear upper panel to repair or replace many of the machine's components. To access the rear electronics enclosure, you must remove the lower access panels.

### 9.2.1 To remove the rear upper panel

1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline pressures read zero before proceeding.
3. Disconnect all electrical cables.
4. To remove the rear panel, fully loosen the three captive screws that hold the panel in place. Remove the panel.
  - If the machine includes integrated suction, disconnect the two tube fittings from the overflow safety trap manifold.
  - If the machine includes electrical outlets, lower the panel and place it so that it does not stress the power cable.

### 9.2.2 To remove the lower access panels

1. Disconnect the power cord from the AC mains supply.
2. Bleed all gas pressure from the machine (Section 9.1).
3. Ensure that all cylinder and pipeline pressures read zero before proceeding.
4. If present, remove the inboard cylinders.
5. Remove the small upper access panel (**A**) to access the display connector board.



6. Remove the large lower access panel (**B**) to access the electrical enclosure.



## 9.3 How to remove the tabletop

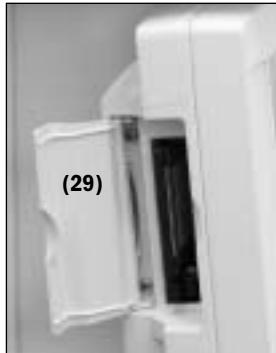
The tabletop is held in place with five captive screws along the periphery of the pan assembly (accessed from below the rim of the tabletop).

- One screw (**A**) is in a deep recess at the right-rear corner of the tabletop.
- Two screws (**B**) are at the front of the tabletop: one screw is at the right corner of the tabletop, one is near the O<sub>2</sub> Flush button.
- To access the remaining two screws (**C**), you must remove the ABS: one screw is at the left corner of the tabletop, one is near the APL Valve.



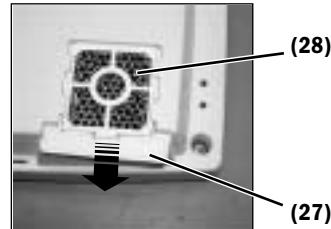
## 9.4 Servicing the Display Unit

**Note** The item numbers appearing in parenthesis in this section refer to items in the parts list in Section 10.7.



The fan filter (28) and the access door (29) to the PCMCIA interface can be replaced with the Display Unit in place.

To replace the filter, slide the filter capsule (27) downward to remove it from the Display Unit.

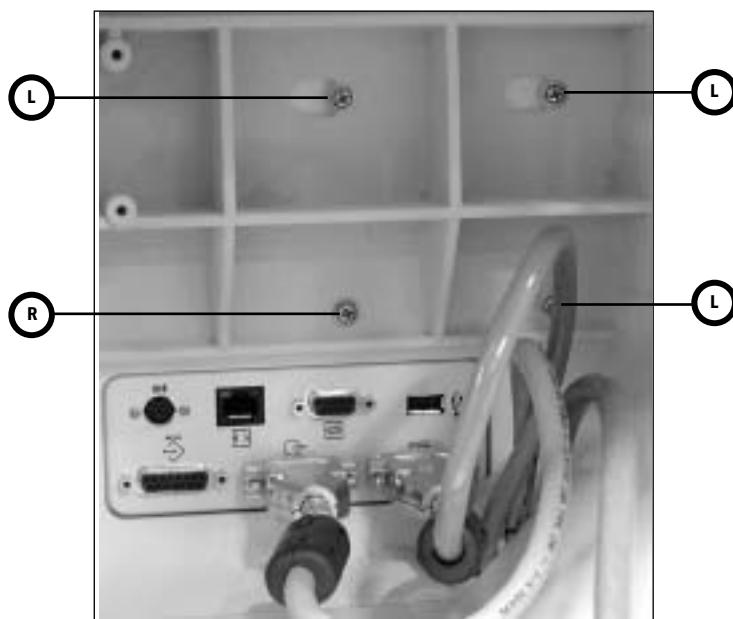


To service other components of the Display Unit, you must first remove the Display Unit from the machine.

### 9.4.1 Remove the Display Unit

The Display Unit is held in place with four screws: three screws fit into keyhole slots and do not have to be fully removed; the fourth screw secures the Display Unit to the front bezel and must be removed to free the Display Unit from the machine.

1. Open the rear access door directly behind the Display Unit.
2. Loosen (**L**) the top two and the bottom-right mounting screws.
3. Remove (**R**) the lower-left mounting screw.

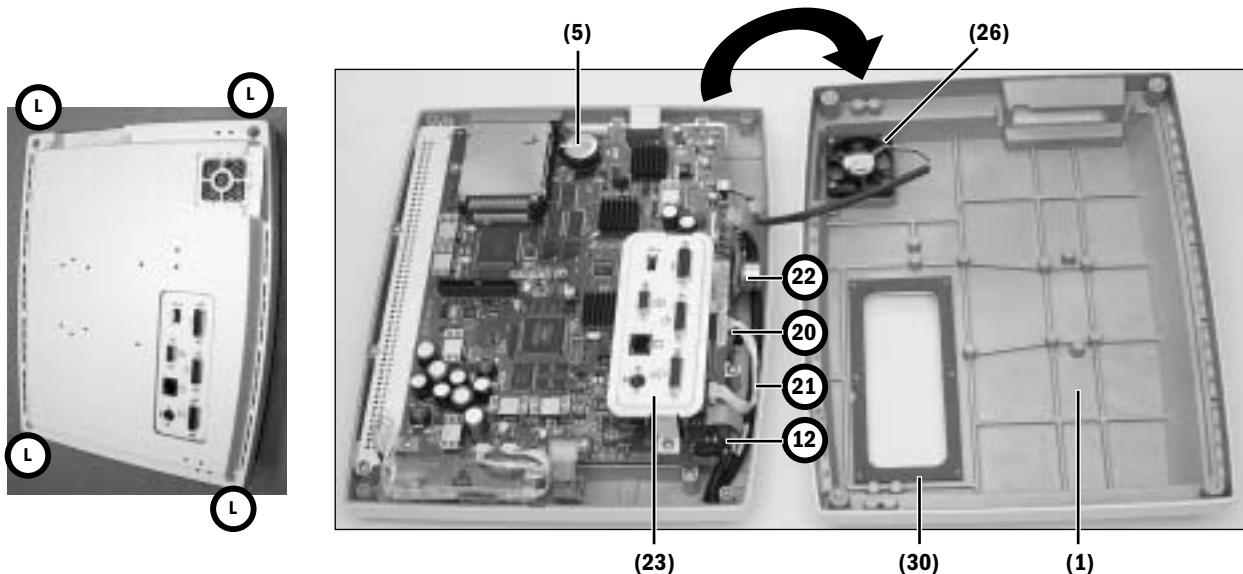


4. Place a protective pad on the tabletop.
5. From the front of the machine, slide the Display Unit toward the center of the machine to free it from the keyhole slots.
6. Lower the Display Unit face down on the protective pad.
7. Remove the cables from the rear connector panel.

## 9.4.2 Disassemble the Display Unit

Place the Display Unit face down on an anti-static pad. Before removing the rear enclosure, ensure that the release tabs on the PCMCIA frame are fully depressed.

1. Loosen (L) the four captive screws at each corner of the rear enclosure.
2. Lift the rear enclosure slightly and pivot it away from the lower enclosure at the bottom side of the Display Unit.



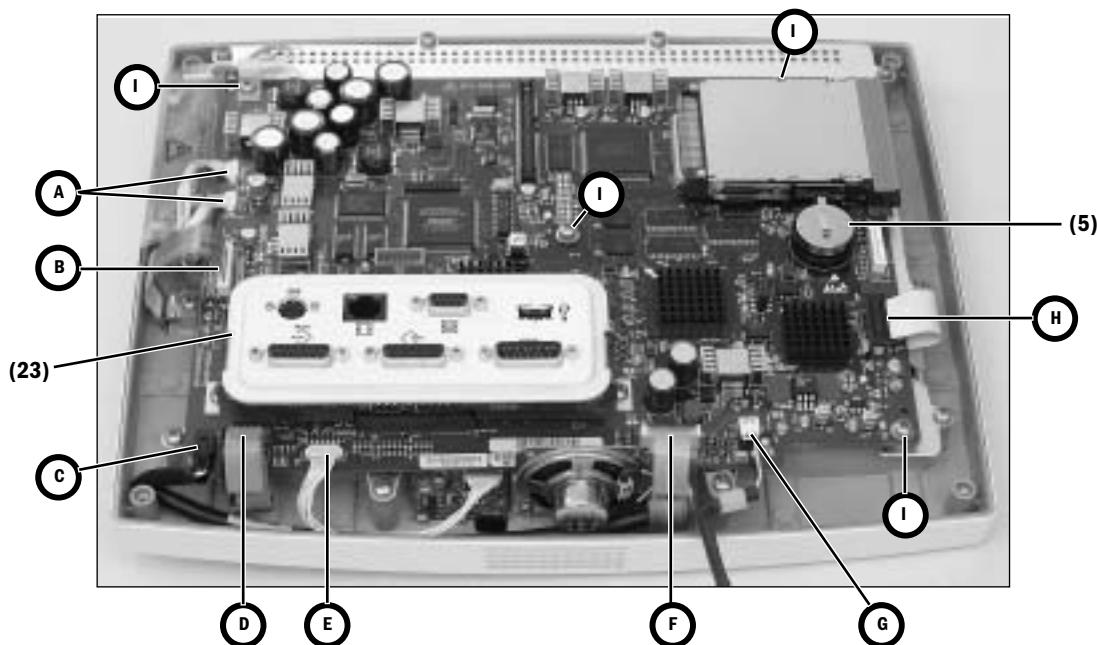
At this point, you can replace the following items (The item numbers refer to the parts list in Section 10.7):

- the **fan** (26)
- the **connector panel assembly** (23)
- the **encoder assembly** (12)
- the **IRDA board** (20) or **IRDA board harness** (21)
- the **battery** (5)
- the **speaker** (22) – To access the mounting screws for the speaker, you must first remove the ten screws that hold the mounting plate to the front enclosure so that you can raise the bottom edge of the assembly slightly – Refer to section 9.4.4.)
- the **rear enclosure** (1) – You can transfer the captive screws to the new enclosure. However, the **gasket** (30) is held in place with adhesive. When replacing the rear enclosure, also include a new gasket.

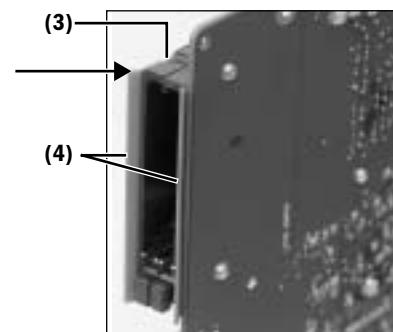
To replace the remaining items requires further disassembly.

### 9.4.3 To replace the CPU board

1. Remove the **connector panel assembly** (23) – two screws.
2. Disconnect the following cables:
  - Inverter harnesses (**A**)
  - Membrane switch flex-cable at ZIF (zero insertion force) connector (**B**)
  - Speaker cable (**C**)
  - Encoder assembly cable (**D**)
  - IRDA board cable (**E**)
  - Membrane switch flex-cable at ZIF (zero insertion force) connector (**F**)
  - Fan cable (**G**)
  - LCD cable (**H**)



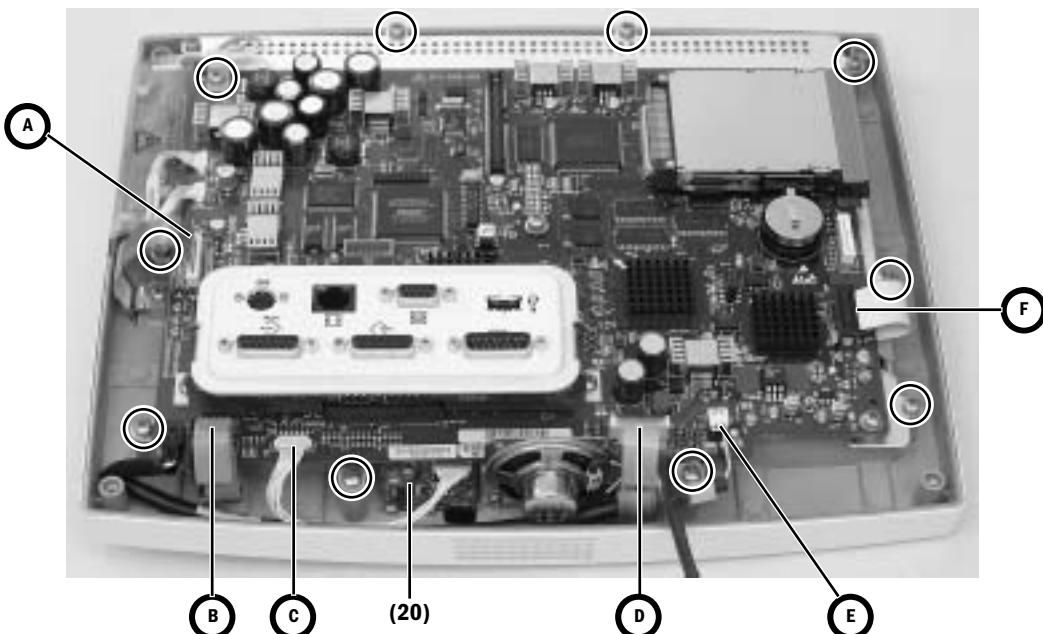
3. Remove the remaining four screws (**I**) that hold the CPU board to the mounting plate.
4. Remove the CPU board from the mounting plate.
5. If you are **replacing the PCMCIA frame** (3) on an existing CPU board (remove four screws on back of CPU board), you must also apply new gaskets (4) to the frame. Align the ends of the gaskets with the top edge of the frame.



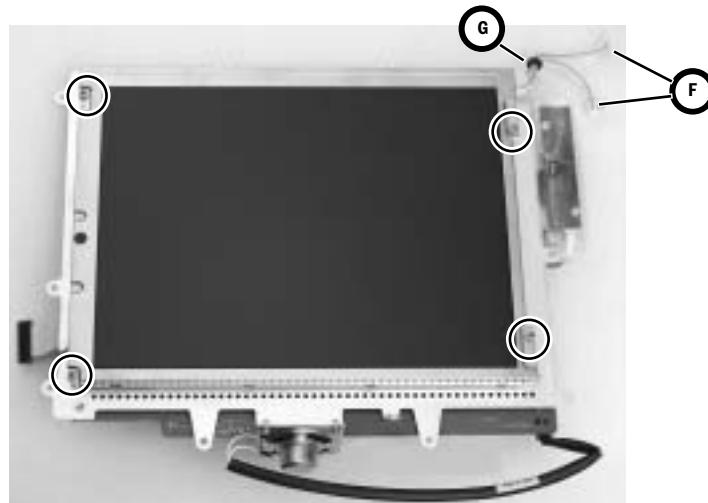
6. Transfer the battery (5) to the new CPU board.
7. Reassemble in reverse order.

#### 9.4.4 To replace the LCD display

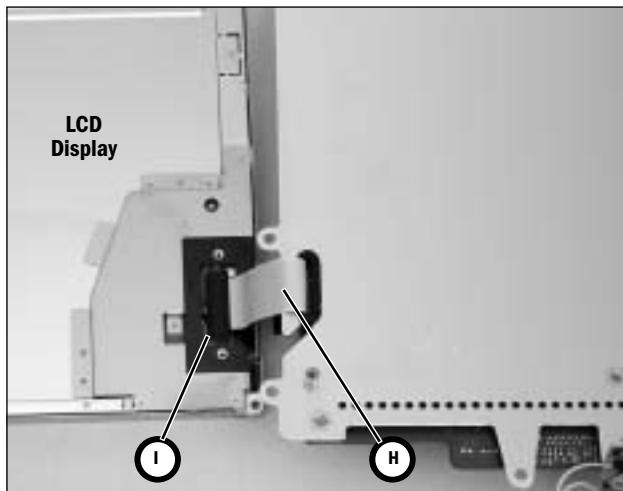
1. Disconnect the following cables:
  - Membrane switch flex-cable at ZIF (zero insertion force) connector (**A**)
  - Encoder assembly cable (**B**)
  - IRDA Interface cable (**C**) – remove IRDA Interface board (20)
  - Membrane switch flex-cable at ZIF (zero insertion force) connector (**D**)
  - Fan cable (**E**)
  - LCD cable (**F**)
2. Remove the ten screws (**circled**) that hold the mounting plate to the front enclosure.



3. Remove the mounting plate assembly from the front enclosure.
4. Disconnect the backlight harnesses (**F**) from the inverter boards.
5. Slide the grommet (**G**) out of the mounting plate slot (transfer to new LCD).
6. Remove the four screws (**circled**) that hold the LCD to the mounting plate.



7. Lift the left side of the LCD display slightly away from the mounting plate to pull some of the display ribbon cable (**H**) to the top side of the plate. Flip the LCD over to the left of the assembly.
8. Disconnect the display ribbon cable (**I**).



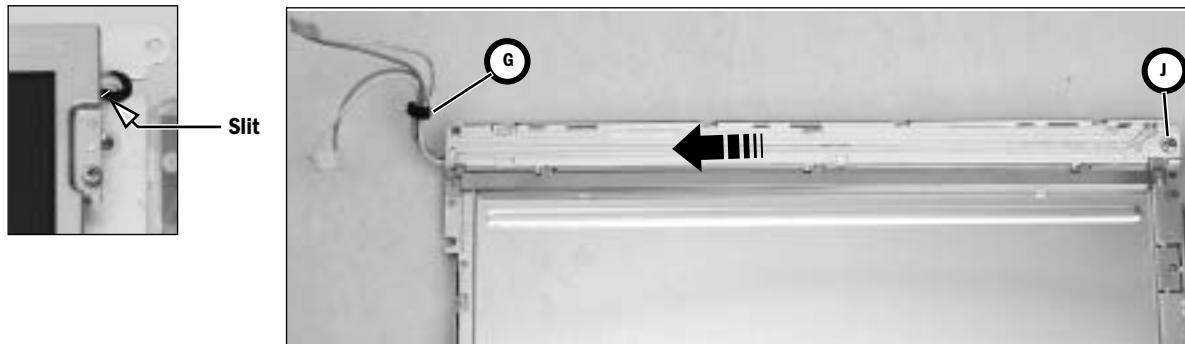
9. Reassemble in reverse order.

**Note:** When replacing the LCD, pull the excess ribbon cable to the bottom side of the plate as you lower the LCD on to the plate. For the backlight harness grommet (**G**), ensure that the slit in the grommet faces toward the inside of the keyhole.

#### 9.4.5 To replace the backlights

The backlight replacement kit includes a backlight assembly (with two backlights) and two inverters with mounting hardware. To replace the backlight assembly follow the procedure in Section 9.4.4 to gain access to the assembly. To replace the inverters, follow the procedure in the next section.

1. Remove the one screw (**J**) that holds the backlight assembly to the LCD.
2. Slide the backlight assembly to the left to free it from the retaining tabs and then lift it out of the holder.



3. Transfer the grommet (**G**) to the new backlight assembly.
4. Reassemble in reverse order.

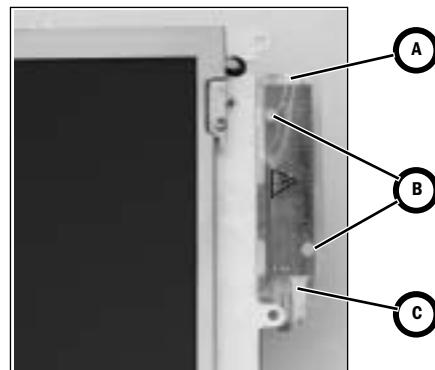
#### 9.4.6 To replace the Inverters

The Display Unit includes two inverters (one for each backlight).

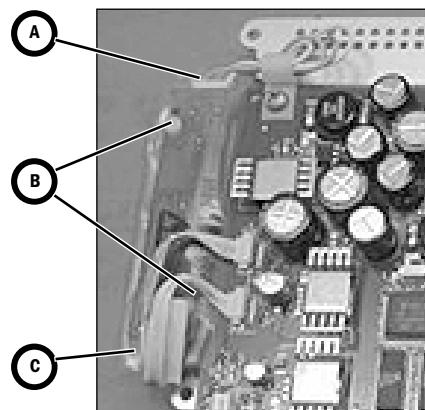
The inverters “sandwich” the mounting plate and use it as a heatsink. Follow the procedure in Section 9.4.4 to gain access to the inverters. Replace one inverter at a time.

1. Disconnect the backlight cable (**A**) from the inverter.
2. Remove the two Nylon screws (**B**) that hold the inverter to the backplate.
3. Slide the inverter out of the sleeve and disconnect it from the CPU harness (**C**).
4. Reassemble in reverse order.

##### The “front” inverter



##### The “rear” inverter



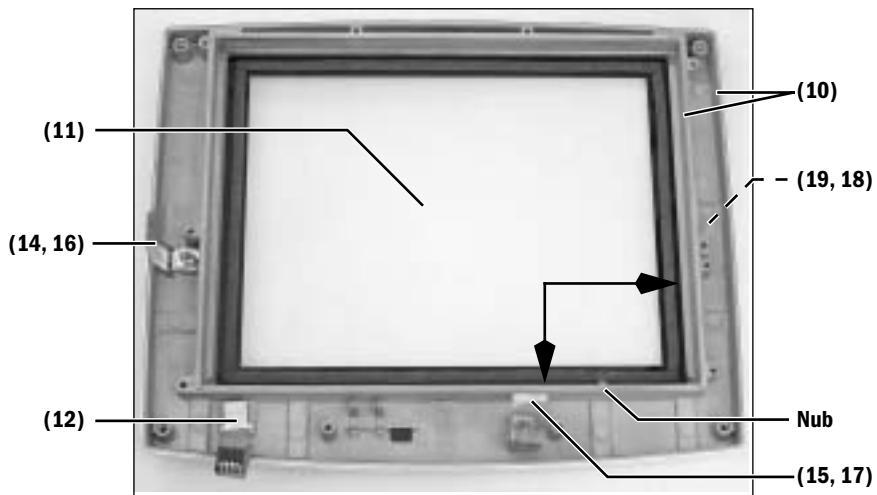
### 9.4.7 To replace the front enclosure or components

Disassemble the Display Unit following procedures in the previous sections to the point where you have removed the mounting plate assembly from the front enclosure.

If you are replacing the front enclosure, you can transfer the encoder (12) assembly to the new enclosure; but, you must build up the replacement enclosure with:

- a new window (11)
- new membrane switches – right-side (14), lower (15), left-side spacer (19)
- new keypads - right-side (16), lower (17), left-side blank (18)
- new EMC gasket (10)

If you are replacing a keypad or a membrane switch, you must replace both items.

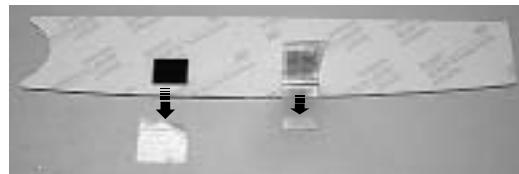


#### To replace the window

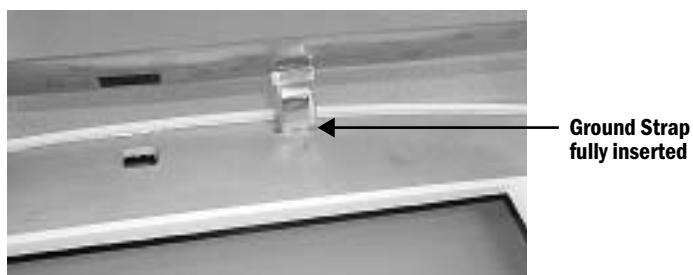
1. Place the front enclosure face up on a flat surface.
2. Press down on one corner of the window to free it from the enclosure.
3. Work your way around the window until you can get a hold of it from the back.
4. Slowly pry the window from the enclosure.
5. Place the front enclosure face down on a flat surface, taking care not to damage the encoder.
6. Remove any remaining residue from the mounting area; clean with isopropyl alcohol.
7. Remove the inside protective material from the front of the window.
8. Peel the front outside frame of the release liner.
9. Lower the window straight down in the enclose, noting the notch in the window and the matching nub on the enclosure.
10. Before seating the window, position it in contact with the bottom and right sides of the frame (see arrows) so that the larger gap between the window and the enclosure is at the top and left edges (as viewed from behind).
11. Remove the protective film from the back side of the window.

**To replace a membrane switch and keypad**

1. Remove the screw that attaches the grounding strap to the enclosure.
2. Pry the membrane switch and keypad from the enclosure.
3. Remove any remaining residue from the mounting area; clean with isopropyl alcohol.
4. Remove the backing from the membrane. Be sure to remove the small backing below the flex cable. For the lower membrane, remove the protective film from the IRDA window.



5. Insert the flex cable and ground strap through the slot in the enclosure. Ensure that all of the ground strap passes through the slot and does not remain folded over under the membrane.



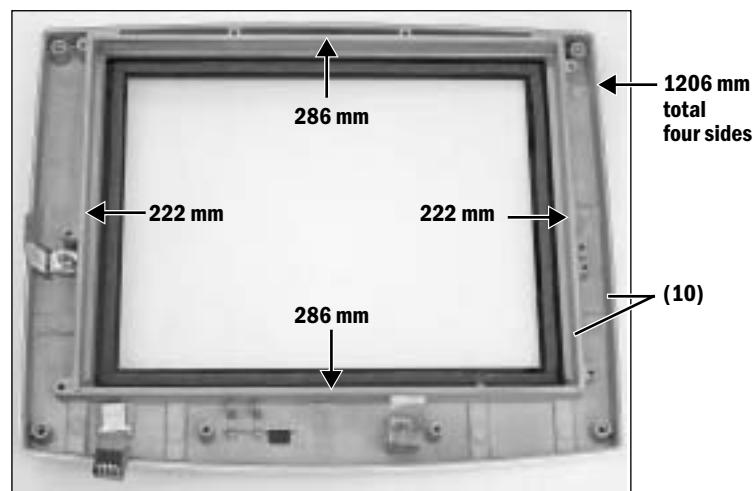
6. Carefully lower the membrane straight down to the enclosure. Seat the membrane in place.
7. Remove the backing from the keypad and install it over the membrane switches.
8. Attach the ground strap to the enclosure.

**To install the EMI gasket**

To fully seal the Display Unit enclosure, you will need approximately 2.3 meters of EMC gasket (10). Cut the gasket into five strips shown below.

**Insert a continuous length of gasket in the outside groove of the enclosure (sparingly apply "Super Glue Gel" to the channels near the corners before installing the gasket).**

**Insert individual lengths of gasket in the inside groove around the window (sparingly apply "Super Glue Gel" to the channels near the corners before installing the gasket).**

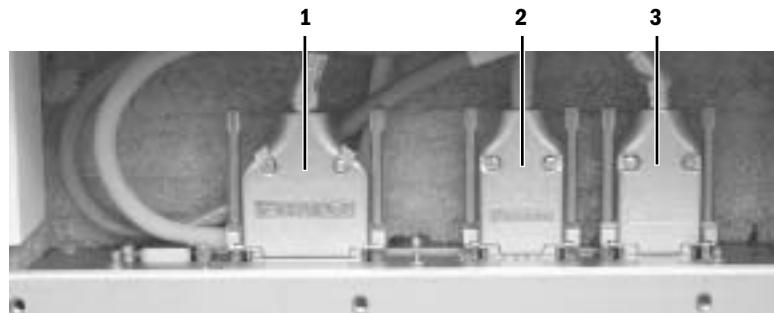


## 9.5 Replacing the Display and MGAS cables

To access the connections at the Display Connector board, remove the small access panel at the rear of the machine (Section 9.2.2).

The top side of the Display Connector board accepts the following cables:

- Airway Module (MGAS) Power Supply board (**1**).
- System Signal Interface to Display Unit (**2**).
- System Power Interface to Display Unit (**3**).

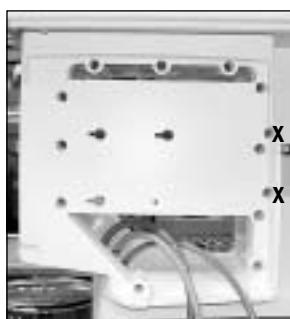


To replace any of these cables, you must remove the oxygen partition that surrounds the MGAS enclosure and MGAS power supply.

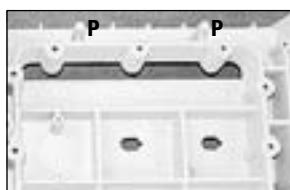
### 9.5.1 Remove the MGAS oxygen partition

1. Remove the rear panel (Section 9.2.1).
2. Remove the MGAS (Airway) module.
3. Remove the MGAS module guide: three screws from outside of machine, two screws at MGAS power supply box inside machine (Section 10.23.1).
4. Remove the Display Unit (Section 9.4.1).
5. From the front of the machine, remove the 11 screws that hold the oxygen partition to the front bezel. Do not remove the two screw (**X**) that hold the front bezel to the vertical support of the vaporizer manifold. When replacing the partition, position it over the two locator pins (**P**) at the top of the bezel opening.
6. Remove the foam plug from under the pan.
7. Replace the cables as necessary.
8. When replacing the partition, ensure that cable are positioned in their respective retaining grooves and that they are long enough to reach the connectors without stressing the cable. Be careful not to pinch the task light harness.
9. Reassemble in reverse order.

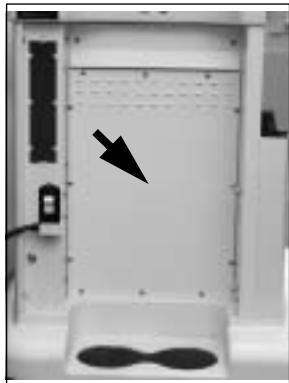
**Front View**



**Rear View**



## 9.6 Servicing the lower electrical enclosure components



### 9.6.1 Power Controller board

The lower electrical enclosure includes the following components (Section 10.8):

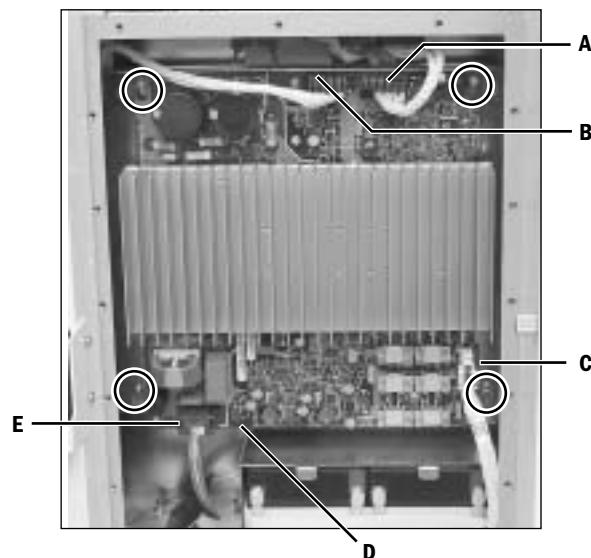
- the Power Controller board
- the Anesthesia Control board
- the Display Connector board
- the backup batteries and the lower enclosure fan.

To replace these components, remove the large access panel at the rear of the machine (Section 9.2). To replace the Display Connector board, also remove the small access panel.

The replacement Power Controller board includes the mounting plate.

1. Disconnect the cables coming from the following components:

- the Display Connector board (**A**),
- the Anesthesia Control board (**B**),
- the batteries (**C**),
- the fan (**D**),
- the line filter (**E**).



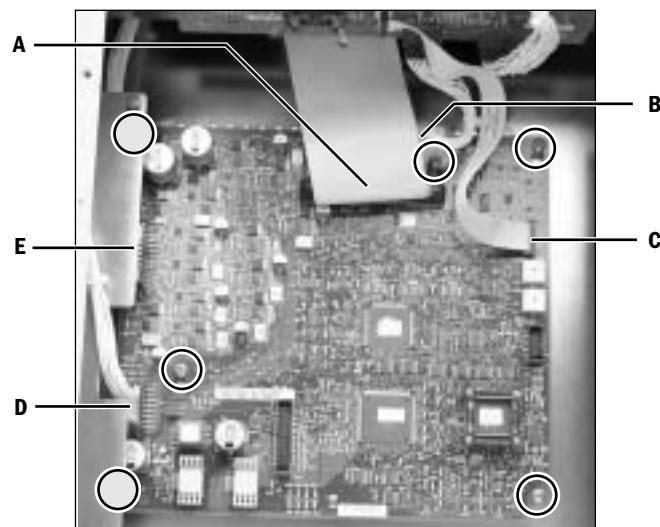
2. Loosen the four screws (**circled**) that hold the Power Controller mounting plate.
3. Lift the Power Controller assembly slightly to release it from the keyhole slots.
4. To replace the Power Controller assembly, reassemble in reverse order.

## 9.6.2 Anesthesia Control board

To replace the Anesthesia Control board, first remove the Power Controller board (Section 9.6.1). Then, follow the procedure below:

1. Disconnect the cables coming from the following components:

- the large ribbon cable from the Pan Connector board (**A**),
- the harness from the Display Connector board (**B**),
- the small ribbon cable from the Display Connector board (**C**),
- the harness from the Power Controller board (**D**),
- the harness from the Pan Connector board (**E**).

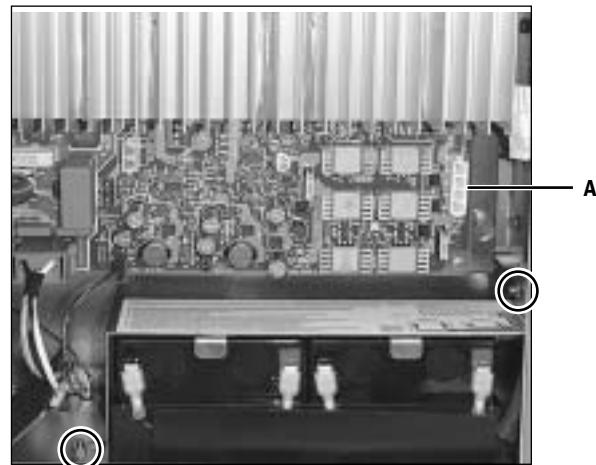


2. Loosen the six screws (**circled**) that hold the Anesthesia Control board to the enclosure.
3. Lift the Anesthesia Control board slightly to release it from the keyhole slots.
4. To replace the Anesthesia Control board, reassemble in reverse order.

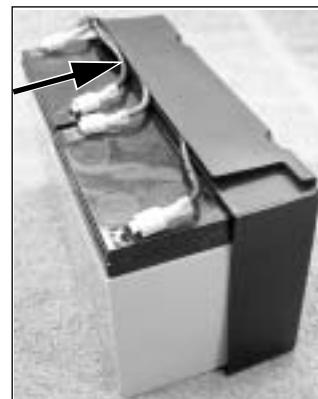
### 9.6.3 Backup batteries

#### To remove the batteries

1. Disconnect the battery cable from the Power Controller board (**A**).



2. Loosen the two nuts (**circled**) that hold the battery restrainer to the enclosure.
3. To remove the restrainer, slide it forward (toward you) and then to the left.
4. Remove the battery pack from the machine.
5. Set the batteries upright (terminals up) and slide them out of the tray.
6. Remove the harness from the batteries.



#### To replace the batteries

- 1.Gently bend the tabs up, just enough for clearance to install the harness.
- 2.Place the batteries side by side and install the harness: red to red, black to black.
- 3.Slide the tray over the side of the batteries.
- 4.Guide the wires of the harness into the lip on the edge of the tray.
- 5.Position the battery tray assembly upright.
- 6.To replace the battery tray assembly, reassemble in reverse order.

### 9.6.4 Fan

The fan is mounted to the side of the enclosure and draws air into the enclosure through the filter on the AC Inlet assembly. For easier access, temporarily remove the backup batteries (Section 9.6.3).

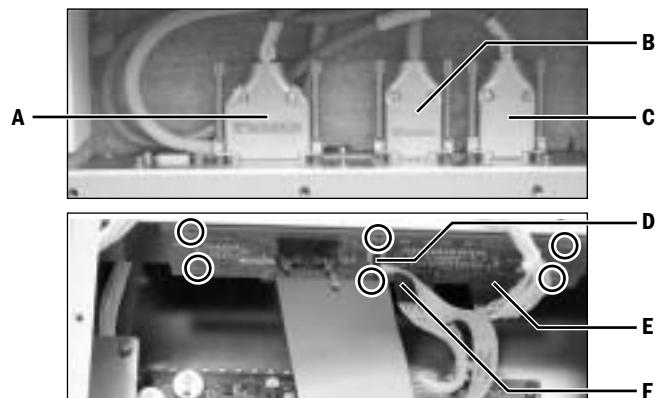
1. Disconnect the fan harness from the Power Controller board (**A**).
2. Remove the two screws that hold the fan to the enclosure.
3. To replace the fan, reassemble in reverse order.
  - Ensure that the fan is oriented with the flow direction arrow pointing toward the inside of the enclosure.



### 9.6.5 Display Connector board

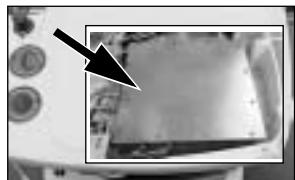
To replace the Display Connector board, first remove the Power Controller board (Section 9.6.1). Then, follow the procedure below:

1. Disconnect the cables from the top of the Display Connector board:
  - Airway Module (MGAS) Power Supply board (**A**).
  - System Signal Interface to Display Unit (**B**).
  - System Power Interface to Display Unit (**C**).
2. Disconnect the cables from the top of the Display Connector board:
  - Harness from Power Controller board (**D**).
  - Harness from Anesthesia Control board (MGAS power) connector (**E**).
  - Ribbon cable from Anesthesia Control board (signal) connector (**F**).



3. Loosen the six screws (**circled**) that hold the Display Connector board to the enclosure.
4. Slide the Display Connector board slightly rearward to release it from the keyhole slots.
5. To replace the Anesthesia Control board, reassemble in reverse order.

## 9.7 Servicing the pan electrical enclosure components



The pan electrical enclosure includes the following components (Section 10.9):

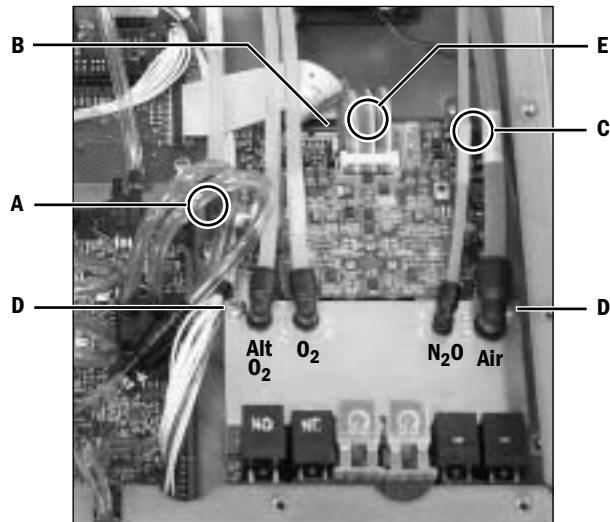
- the Electronic Gas Mixer assembly
- the Ventilator Interface board
- the Filter board
- the Pan Connector board
- the pan enclosure fan

To replace these components, remove the tabletop (Section 9.3) and the pan enclosure cover.

### 9.7.1 Electronic Gas Mixer assembly

The following procedure describes how to replace the Electronic Gas Mixer assembly.

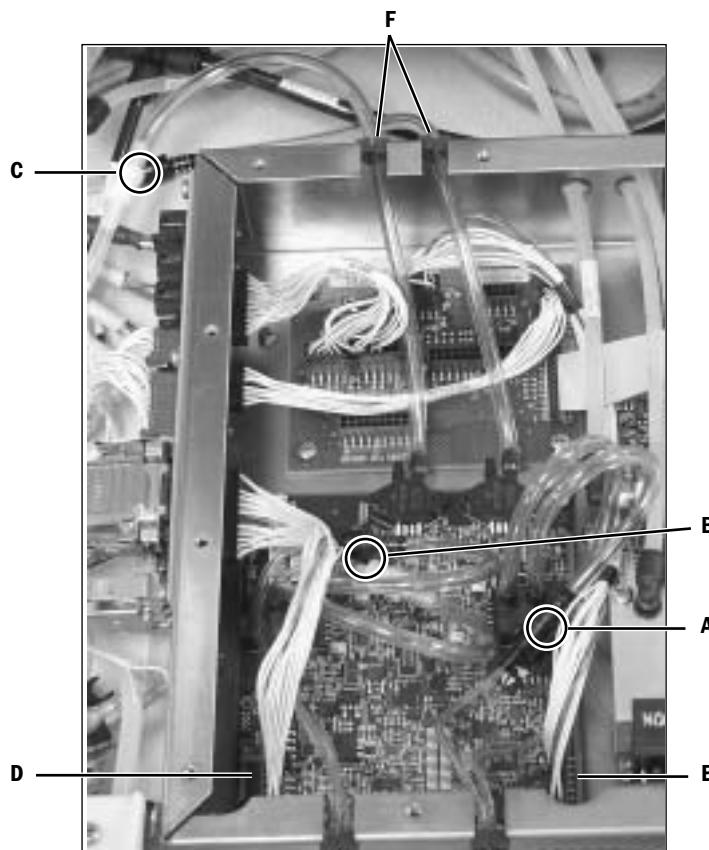
1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline pressures read zero before proceeding.
3. Disconnect the inlet tubing elbow fittings from the manifold. If the machine does not include N<sub>2</sub>O, transfer the plug from the N<sub>2</sub>O inlet to the replacement assembly.
4. Disconnect outlet tubing elbow fitting (A).



5. Disconnect the ribbon cable from the Pan Connector board (B).
6. Disconnect the fan harness (C).
7. Remove the two screws (D) that hold the manifold to the enclosure.
8. Remove the mounting screw (E) at the front edge of the main circuit board.
9. To replace the Electronic Gas Mixer assembly, reassemble in reverse order.

### 9.7.2 Ventilator Interface board

1. Disconnect the white and black inline tubing fittings from the Inspiratory pressure transducer (**A**).
2. Disconnect the blue and yellow inline tubing fittings from the Expiratory pressure transducer (**B**).
3. Disconnect the white inline tube fitting from the Manifold pressure transducer and the black inline tube fitting from the Airway pressure transducer (**C**).



4. Disconnect the harness from the Filter board (**D**).
5. Disconnect the harness from the Pan Connector board (**E**).
6. Remove the four mounting screws, one at each corner, that hold the board to the enclosure.
7. To replace the Ventilator Interface board, reassemble in reverse order.
  - Ensure that the tubing fittings are connected to like color fittings and that the tubing will not kink when the cover is replaced.
  - Transfer the grommets to the Manifold and Airway pressure tubing (**F**).

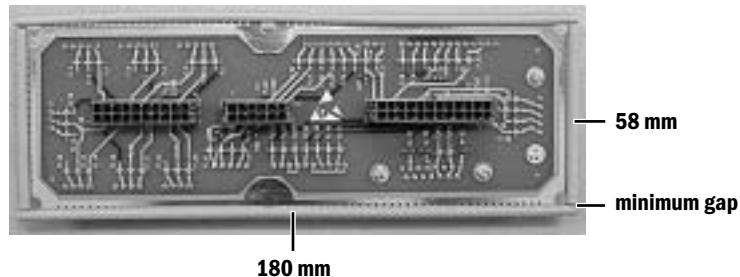
### 9.7.3 Filter board

Before replacing the Filter board, you must apply an EMI gasket around the edges of the board that face the enclosure. Refer to section Section 10.9 for required parts.

You can replace the Filter board without removing the enclosure cover, if you do not have to remove cover for other reasons.

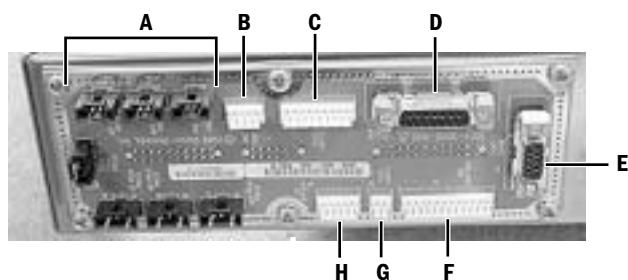
- Cut the gasket pieces to length and apply them to the board as shown:

- Do not block the mounting holes.
- Keep the corner gaps to a minimum.



- Disconnect all cables and harnesses from the front-side of the board:

- Transducer cables from the pipeline and cylinder gas supplies (**A**)
- Harness from system switch (**B**)
- Harness from SCGO/ACGO (**C**)
- Cable from flow sensors (**D**)
- Cable from Vent Engine board (**E**)
- Harness from ABS switches (**F**)
- Harness from task lights (**G**)
- Harness from Alt O<sub>2</sub> (**H**)

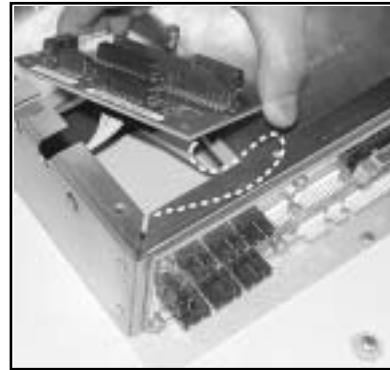


- Remove the six screws that hold the Filter board to the enclosure. (If the enclosure cover is removed, disconnect the three harnesses from the back-side of the board before removing the mounting screws.)
- If the cover is in place, pull the Filter board away from the enclosure and disconnect the three harnesses from the back-side of the board.
- To replace the Filter board, reassemble in reverse order.

#### **9.7.4 Pan Connector board**

The Pan Connector board is a wiring interface between the lower electrical enclosure components and the pan electrical enclosure components (refer to Figure 11-8).

1. Disconnect the wiring from the top-side of the Pan Connector board:
  - Two harness connectors coming from the Filter board.
  - One harness connector coming from the Ventilator Interface board.
  - One ribbon cable connector coming from the Electronic Gas Mixer.
2. Remove the four screws that hold the Pan Connector board to the enclosure.
3. Lift the Pan Connector board away from the enclosure and disconnect the large ribbon cable and the harness from the under-side of the board.
4. To replace the Pan Connector board, reconnect the large ribbon cable and the harness to the under-side of the board.
5. Lower the Pan Connector board over the gasketed opening in the pan enclosure.
  - Keep the extra length of ribbon cable in the pan area.
  - Fold the ribbon cable under the enclosure toward the front of the machine.

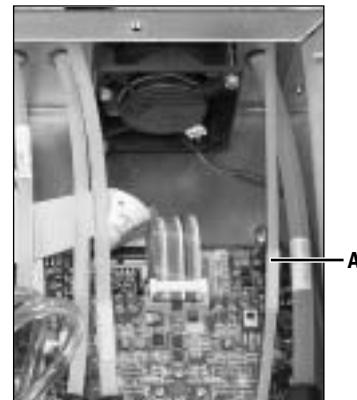


6. Secure the board to the enclosure.
7. Reconnect the harnesses and ribbon cable to the top-side of the board.
8. Reassemble in reverse order.

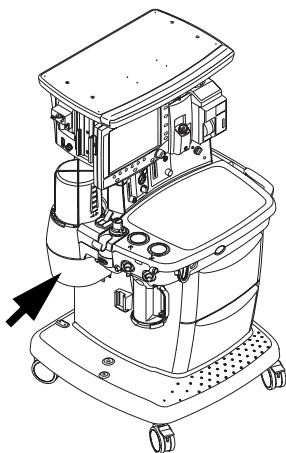
#### **9.7.5 Pan enclosure fan**

The fan is mounted to the back-side of the enclosure and draws air into the enclosure.

1. Disconnect the fan harness from the Mixer board (A).
2. Remove the two screws that hold the fan to the enclosure.
3. To replace the fan, reassemble in reverse order.
  - Ensure that the fan is oriented with the flow direction arrow pointing toward the inside of the enclosure.



## 9.8 Servicing the Vent Engine

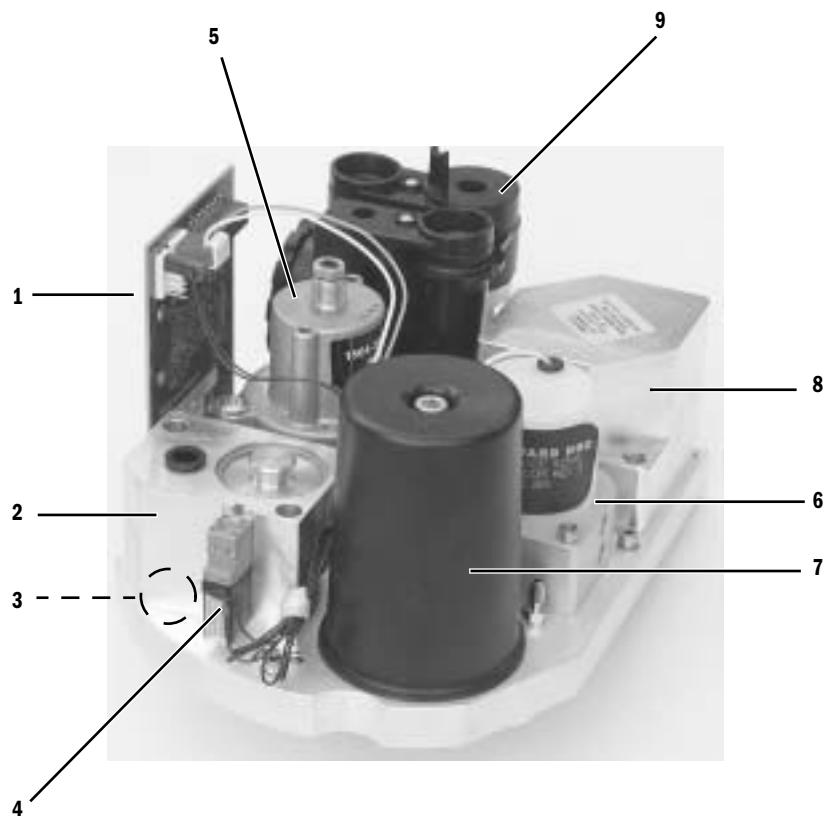


The Vent Engine is found in a housing located below the breathing system bellows assembly.

The Vent Engine includes the following subassemblies.

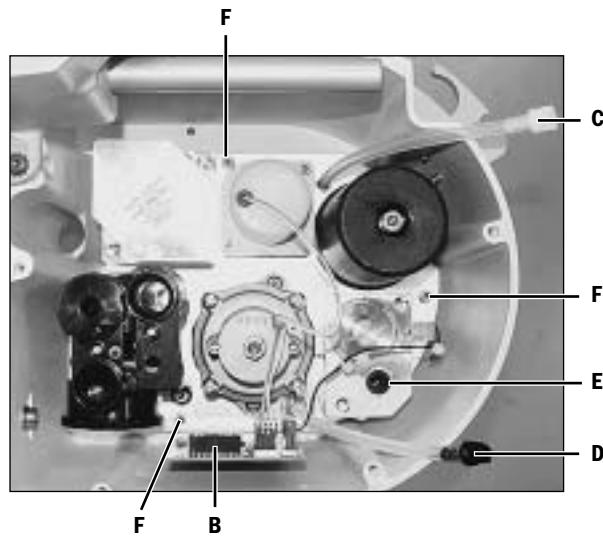
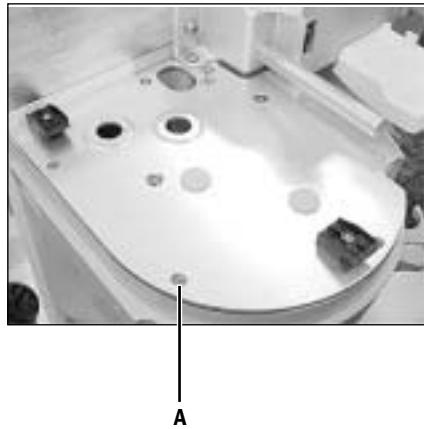
- Vent Engine Connector board (**1**)
- Gas Inlet Valve Assembly (**2**)
- Inlet Filter (**3**) - located under the gas inlet valve
- Inlet Valve Solenoid (**4**)
- Drive Gas Regulator (**5**)
- Flow Control Valve (**6**)
- Reservoir (**7**)
- Drive Gas Check Valve (**8**)
- Interface Manifold (**9**)

To replace any of the Vent Engine components, you must first remove the Vent Engine from the housing (refer to Section 9.8.1).



### 9.8.1 To remove the Vent Engine

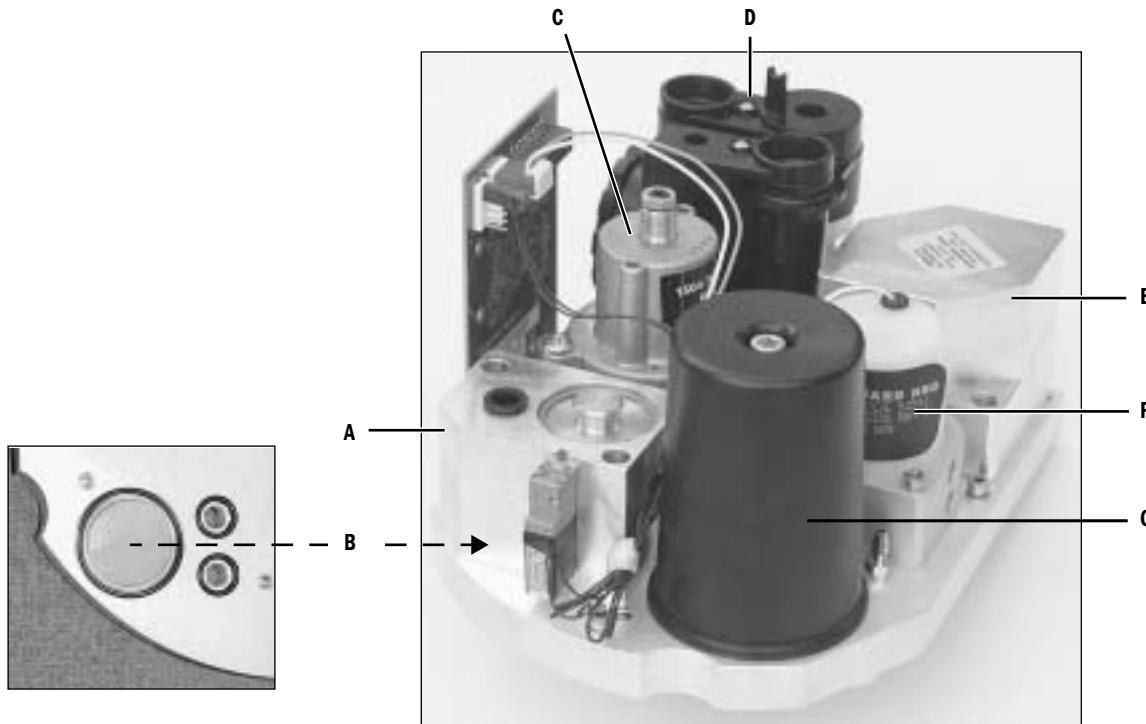
1. Disconnect pipeline supplies; close cylinder valves; bleed off pressure.
2. Remove the ABS breathing system.
3. Remove the Exhalation valve.
4. Remove the scavenging downtube.
5. Loosen the five captive screws (**A**) that hold the Vent Engine cover to the housing. Raise the cover to access the Vent Engine.



6. Disconnect the Vent Engine harness (**B**).
7. Disconnect the white tube-coupler (**C**) – inline with tube to manifold pressure transducer on the Ventilator Interface Board.
8. If present, disconnect the black tube-coupler (**D**), inline with tube to AGSS flow indicator.
9. Disconnect the drive gas hose (**E**).
10. Loosen the three captive screws (**F**) that hold the engine manifold to the housing.
11. Lift the Vent Engine out of the housing.
12. To replace the Vent Engine, reassemble in reverse order.

## 9.8.2 Replacing Vent Engine components

Refer to Section 6 for Vent Engine components that are to be serviced under regular maintenance. Most of the components on the Vent Engine can be replaced by removing the mounting screws and remounting the replacement part in place.



**Gas Inlet Valve (A)** Inspect the two o-rings that seal it to the manifold. Replace as necessary. To replace GIV shuttle valve components, refer to Section 9.8.3.

**Inlet Filter (B)** Install the filter with the smooth side facing up. Inspect the o-ring. Replace as necessary.

**Regulator (C)** Inspect the two o-rings that seal it to the manifold. Replace as necessary. Perform the Drive Gas Regulator calibration in Section 5.3.

**Interface Manifold (D)** Inspect the two o-rings that seal it to the manifold. Replace as necessary. Lubricate o-rings sparingly with Krytox.

**Drive Gas Check Valve (E)** Inspect the o-ring that seal it to the manifold. Replace as necessary. Clean the seat on the manifold and the seal on Drive Gas Check Valve with isopropyl alcohol.

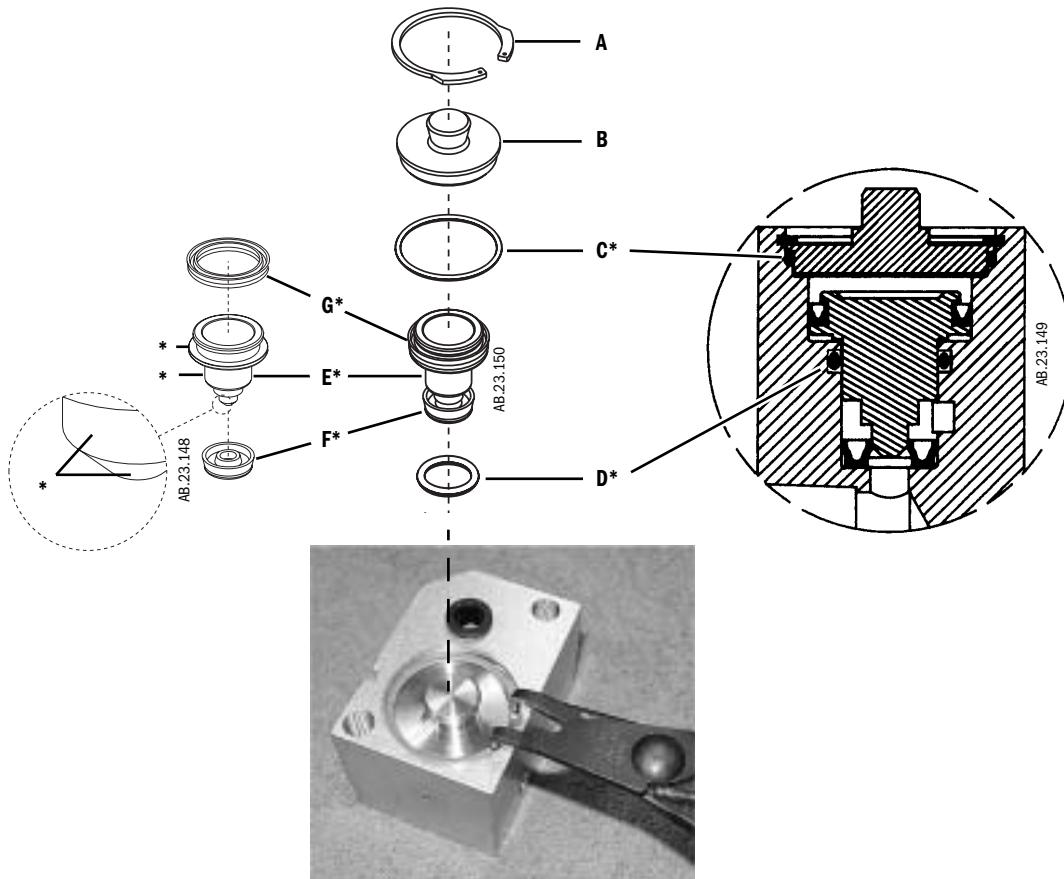
**Inspiratory Flow Valve (F)** Note orientation of the flow valve. Inspect the two o-rings that seal it to the manifold. Replace as necessary. Perform the Inspiratory Flow Valve calibration in Section 5.4.4.

**Reservoir (G)** Inspect the two o-rings: reservoir to manifold, reservoir to screw head. Replace as necessary.

**Inlet Valve Solenoid (H)** Inspect seal between solenoid and GIV body. Replace as necessary (included with solenoid).

### 9.8.3 Replacing GIV components

Lubricate items marked with an asterisk (\*) sparingly with Krytox.



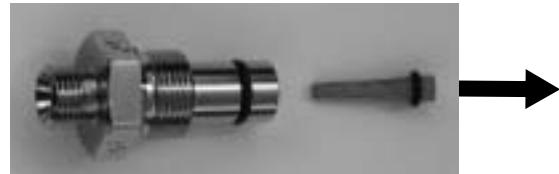
1. Remove the retaining ring (**A**) and the GIV cap (**B**).
2. Use pneumatic pressure to remove the shuttle. Cover the shuttle with a cloth and briefly apply pressure (connect the drive gas hose or use pipeline pressure) through the drive gas inlet.
3. Remove the upper o-ring (**C**) and the lower o-rings (**D**\*).
4. Install the lower o-ring (**D\***).
5. Lubricate the shuttle (**E**) at the three areas (\*) shown: the circumference of the shuttle where the upper and lower u-cup seals are placed and the body part of the shuttle that slides along the lower o-ring.
6. Install the lower u-cup seal (**F\***) and the upper u-cup seal (**G\***) on the shuttle.
7. Press the shuttle assembly into the GIV manifold.
8. Install the upper o-ring (**C\***).
9. Install the cap (**B**) and the retaining ring (**A**).
10. Reassemble in reverse order.

## 9.9 Servicing the pipeline inlet manifold components

The pipeline inlet filter and the inlet check valve can be replaced without removing the pipeline manifold from the machine. To replace the pressure transducer, you have to remove the manifold.

### 9.9.1 Replace pipeline inlet filter

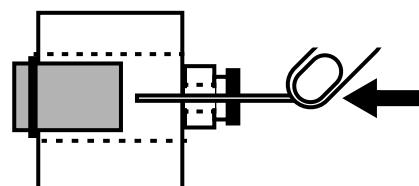
1. Remove the pipeline inlet fitting.
2. Pull the pipeline inlet filter out of the fitting. The o-ring should come out with the filter.



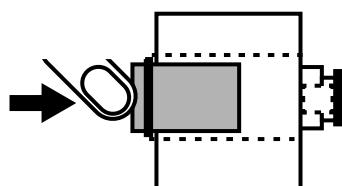
3. Install the new pipeline inlet filter in the pipeline inlet fitting. The new filter comes with an o-ring.

### 9.9.2 Replace pipeline inlet check valve

1. Remove the rear panel (Section 9.2).
2. Remove the pipeline inlet fitting.
3. The Air and O<sub>2</sub> pipeline manifolds include a drive gas connection at the back of the manifold. Remove the drive gas tube or plug to access the check valve.
4. From the back of the pipeline manifold, use a thin tool to push out the check valve. (For an N<sub>2</sub>O manifold, you will have to carefully apply pressure at the outlet of the manifold – with a syringe for example – to gently force the check valve out of the manifold).



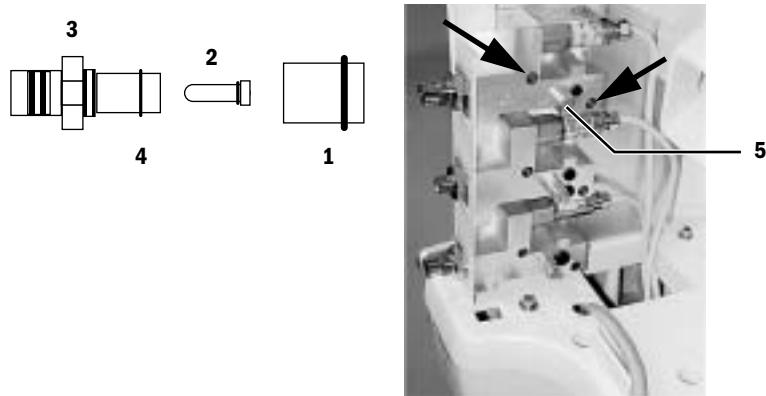
5. Push the new check valve into the opening, using the same thin tool. The new check valve includes an o-ring – orient it toward the pipeline inlet. **Note:** Make sure to push the new check valve all the way back into the opening until it bottoms out on the shoulder.



6. Install the pipeline inlet fitting.

### 9.9.3 Replace the inlet manifold

1. Remove the rear panel (Section 9.2).
2. Disconnect the tubing from the manifold outlet(s).
3. Remove the two screw that hold the manifold to the side extrusion.



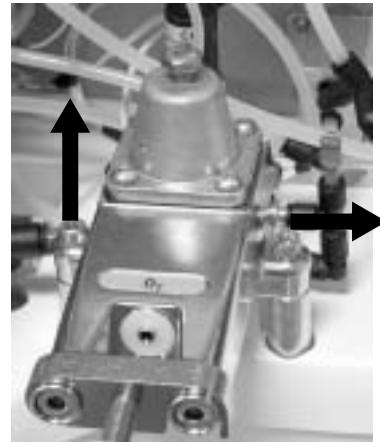
4. Transfer the following item to the replacement manifold or install new as required.
  - pipeline check valve (1)
  - inlet filter (2)
  - inlet fitting (3) and o-ring (4)
  - relief valve (5)
5. Transfer the pressure transducer to the new supply (Section 9.11).
  - Remove any teflon tape remnants from the transducer mounting threads (transducer and module).
  - Apply 1-1/4 turns of new teflon tape around the treads. Verify that the first few threads are free of tape.
  - Install the transducer.
6. To reassemble, perform the previous steps in reverse order.
7. Perform the checkout procedure (Section 3).

## 9.10 Service the cylinder supply modules

**⚠ WARNING** Be careful not to expose internal components to grease or oil (except Krytox or equivalent).

### 9.10.1 Replace primary regulator module (complete replacement)

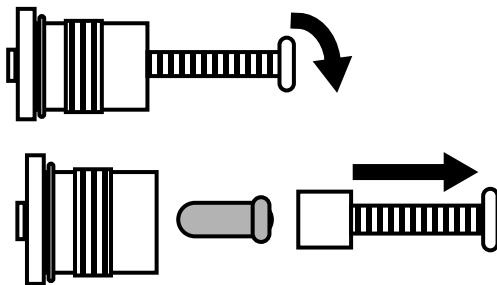
1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline pressures are at zero before proceeding.
3. Remove the rear panel (Section 9.2).
4. Disconnect the output tube fitting.
5. Remove the three mounting screws and lockwashers.
6. Remove the elbow fitting from the replacement gas supply.
7. Transfer the pressure transducer to the new supply (Section 9.11).
  - Remove any teflon tape remnants from the transducer mounting threads (transducer and module).
  - Apply 1-1/4 turns of new teflon tape around the treads. Verify that the first few threads are free of tape.
  - Install the transducer.
8. To reassemble, perform the previous steps in reverse order.
  - Pull on the cylinder output fitting to ensure it is locked in place.
9. Check the output of the regulator BEFORE you install the rear panel. Adjust if necessary (Section 5.1).
10. Perform the checkout procedure (Section 3).



### 9.10.2 Replace cylinder inlet filter

1. Open the cylinder yokes.
2. Remove the inlet adapter from the cylinder yoke, using a 4 mm hex wrench.  
**Note:** A brass retaining ring keeps the filter inside the inlet adapter.
3. Thread a 6-mm screw (two turns only) into the brass retaining ring and pull it out.

**⚠ CAUTION** Be careful not to crush the filter. Do not thread in the screw more than two full turns.



4. Remove the filter.
5. Install the new filter and brass retaining ring.
6. Install the inlet adapter in the cylinder yoke.
7. Perform the checkout procedure (Section 3).

### 9.10.3 Replace cylinder check valve

The cylinder check valve is not a replaceable item. If the check valve is defective, you must replace the complete cylinder supply module.

## 9.11 Replace gas-supply pressure transducers

The gas-supply pressure transducer includes an integral cable that connects to the Filter board on the pan enclosure. The transducer itself is mounted directly to the supply module. To replace a pressure transducer (pipeline or cylinder) you have to remove the module from the machine.

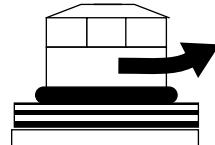
1. To access the Filter board, remove the tabletop (Section 9.3).
2. Disconnect the transducer cable from the Filter board.
3. Remove the supply module to access transducer.
  - For cylinder supplies, refer to Section 9.10.
  - For pipeline supplies, refer to Section 9.9.
4. Remove the transducer from the module.
5. Install the new transducer.
  - For pipeline transducers:
    - Be sure that an o-ring is in place.
  - For cylinder transducers:
    - Remove any teflon tape remnants from the module.
    - Apply 1-1/4 turns of teflon tape around the treads of the transducer. Verify that the first few threads are free of tape.
    - Install the transducer.
6. To reassemble, perform the previous steps in reverse order.
7. Perform the checkout procedure (Section 3).



## 9.12 Service vaporizer manifold parts

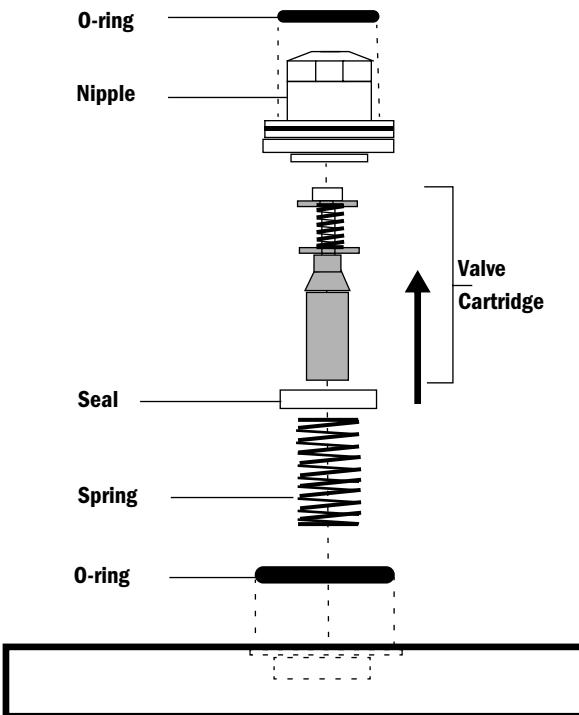
### 9.12.1 Repair manifold port valve

1. Set the system switch to Standby.
2. Remove the vaporizers from the vaporizer manifold.
3. Using a 14-mm wrench, carefully remove the valve nipple (threaded).



4. Disassemble as necessary to replace parts. The following illustration shows the parts.

**Note:** The port valve replacement kit includes the valve cartridge assembly and the seal. The kit does not include o-rings.



5. When installing a new valve cartridge assembly into the vaporizer manifold, put a light coat of Krytox on the bottom portion of the cartridge. The bottom portion of the cartridge is defined as the brass surface that is inserted in the lower spring. **Note:** Do not apply Krytox to the valve seal.
6. Verify that the parts are free of dust and dirt.
7. To reassemble, perform the previous steps in reverse order.
8. Complete the port valve checkout procedure described below (Section 9.12.2).

## 9.12.2 Checkout procedure for manifold port valve

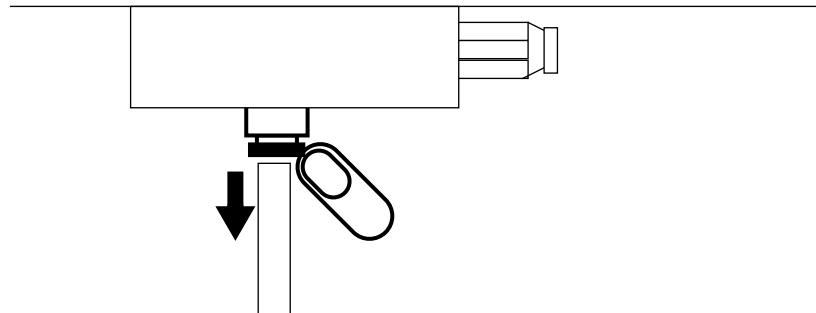
Use the Vaporizer Manifold Valve Test Tool to perform the checkout procedure for the manifold port valve. This tool and test procedure are intended for use only when the valve cartridge assembly is replaced.

**Note** This replacement and test procedure is a service action and is not part of the maintenance program.

1. Set the system switch to Standby.
2. After replacing the valve cartridge assembly, remove the vaporizer port o-ring.
3. Attach the valve tester to the top of the valve by sliding the bottom of the tester onto the o-ring groove.
4. Tighten the tester screw down onto the valve until the screw bottoms out on the top of the valve. The tester o-ring should create a seal with the top of the valve.
5. With the Inspiratory Flow Sensor open to atmosphere (do no plug the right-hand port), verify that the system passes the Low P leak check in the System Checkout (Section 3.2.1).
6. Remove the valve tester.
7. Reassemble the vaporizer port o-ring.
8. Conduct a negative low-pressure leak test on the system.
9. Perform system “All checks” (Section 3.2).

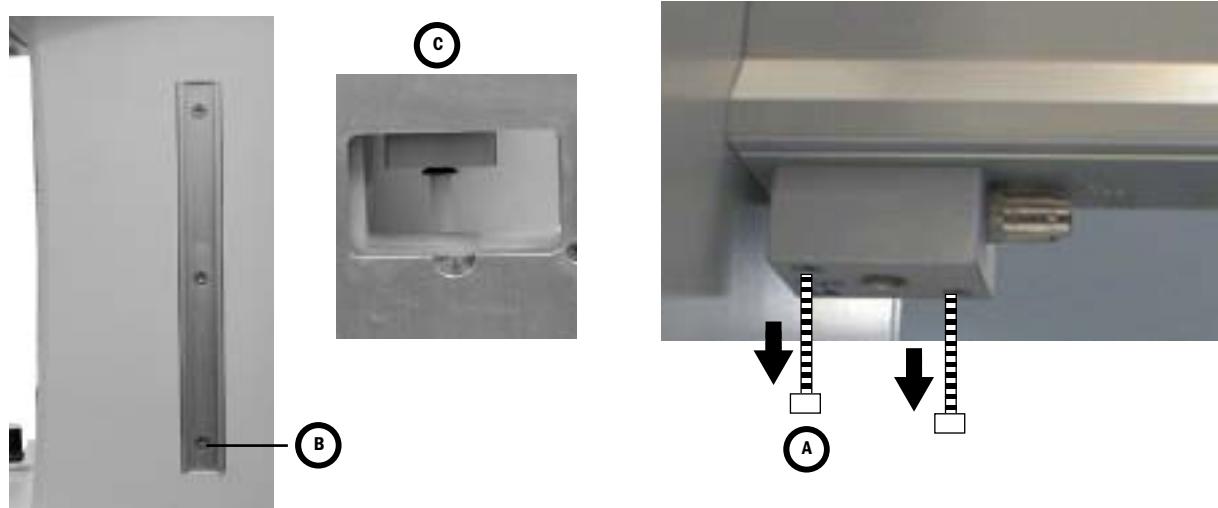
### 9.12.3 Replace vaporizer manifold check valve

1. Set the system switch to Standby.
2. Remove the vaporizers from the vaporizer manifold.
3. Remove the upper rear panel.
4. Disconnect the tubing from the valve block.



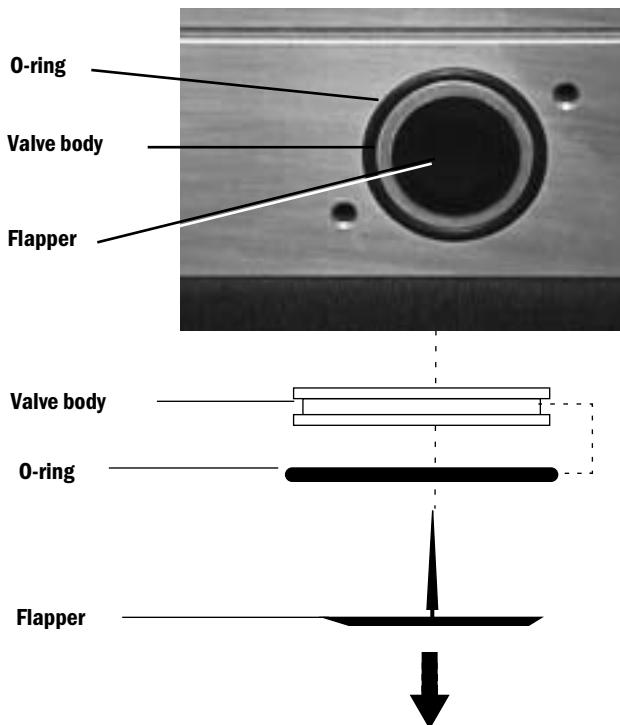
5. Remove the valve block.

- To access the left-hand mounting screw (**A**), remove the right (viewed from front) side panel (**B**).
- The right-side extrusion include an access hole (**C**) for removing the left-hand mounting screw.
- **Note:** For early production machines that do not have an access hole in the extrusion, you must remove the vaporizer manifold to remove the valve block.



**Note** The valve body, o-ring, and flapper do not come out with the block. They stay intact at the bottom of the vaporizer manifold.

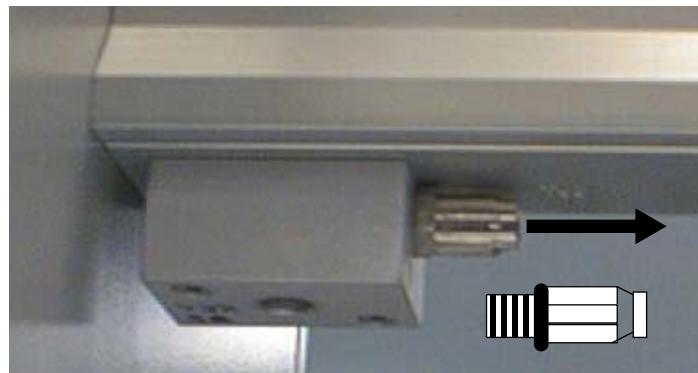
6. Pull the flapper out of the valve body.



7. Using a hex wrench, put the wrench through one of the holes of the valve body and pull down to remove the valve body and o-ring.
8. Verify that parts are free of dust and dirt.
9. Replace the flapper by inserting the flapper stem and gently pulling the stem until the flapper secures to the valve body.
10. Lightly lubricate the o-ring with Krytox.
11. Place the lubricated o-ring on the valve body port at the bottom of the manifold.
12. Gently install the valve body in the manifold:
  - Check that the o-ring makes a good seal between the manifold and the valve body.
  - Check that the flapper valve makes solid contact with the valve body.
13. Install the valve block.
14. Reconnect the tubing to the valve block. Pull on the tube to ensure that it is locked in the fitting.
15. Install the vaporizer front panel.
16. Perform the checkout procedure (Section 3).

#### **9.12.4 Replace vaporizer pressure relief valve**

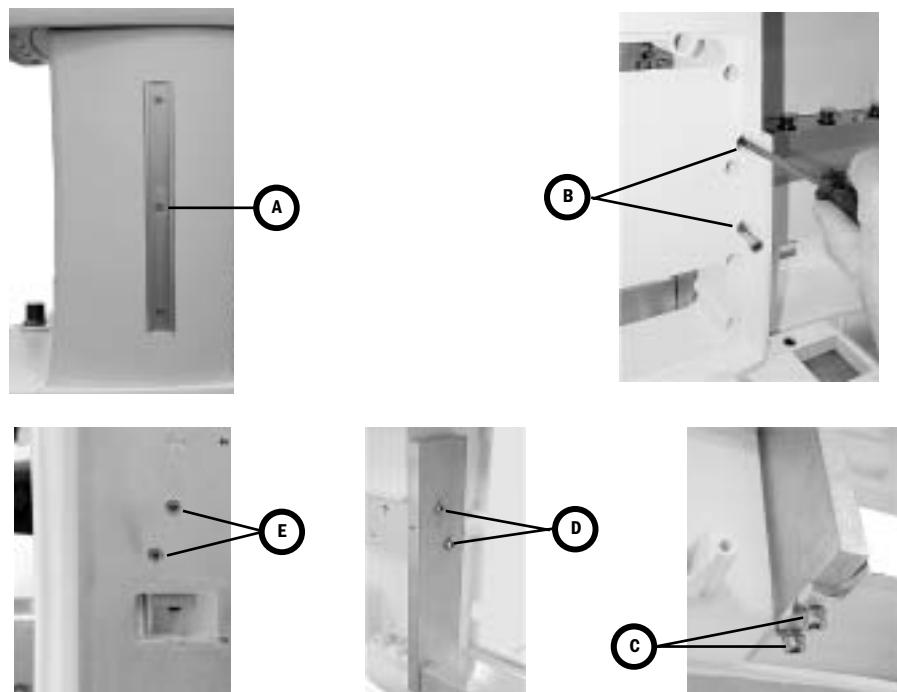
1. Set the system switch to Standby.
2. Remove the vaporizers from the vaporizer manifold.
3. Remove the upper rear panel (Section 9.2).
4. Using a 13mm open ended wrench, remove the vaporizer pressure relief valve by turning counterclockwise.



5. Verify that the parts are free of dust and dirt.
6. Install a new vaporizer pressure relief valve.
7. To reassemble, perform the previous steps in reverse order.
8. Perform the checkout procedure (Section 3).

### 9.12.5 Replace vaporizer manifold

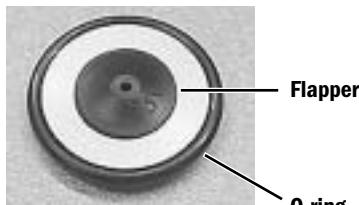
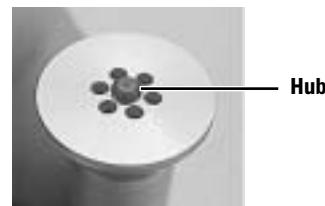
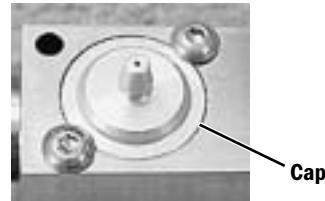
1. Remove the upper rear panel (Section 9.2).
2. Remove the Display Unit.
3. Remove the right side panel (**A**).
4. From the front of the machine, remove the two screws (**B**) that hold the front bezel to the vertical support.
5. From the back of the machine, remove the two screws (**C**) that hold the vaporizer manifold vertical support to the horizontal bracket.
6. From the back of the machine, remove the two screws (**D**) that hold the vertical support to the vaporizer manifold.
7. Remove the vertical support from the machine.
8. While holding the vaporizer manifold, remove the two screws (**E**) at the right-hand extrusion to release the manifold.



9. Install the new vaporizer manifold in reverse order. Do not fully tighten the screws until they are all in place.
  - Attach the new manifold to the right-hand extrusion (**E**).
  - Attach the vertical support to the vaporizer manifold (**D**).
  - Attach the bottom of the vertical support to the horizontal bracket (**C**).
  - Attach the vertical support to the front bezel (**B**).
10. Tighten the mounting screws in the following order: **E**, **D**, **C**, **B**.
11. Reassemble the machine.
12. Perform the checkout procedure (Section 3).

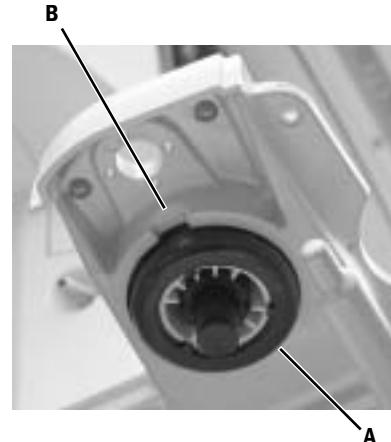
## 9.13 Clean or replace ACGO port flapper valve

1. Remove the tabletop (Section 9.3).
2. Remove the ACGO cap mounting screws.
3. Remove the cap.
4. Examine the flapper and disk for obstructions or debris. Clean with isopropyl alcohol if necessary; retest.
5. If leak persists, replace the flapper.
  - Remove the flapper from the check valve disk.
  - Clean the new flapper with isopropyl alcohol.
  - Apply a drop of isopropyl alcohol to the center hub of the new flapper.
  - Before the alcohol evaporates, align the center hub of the new flapper with the center hole of the check valve disc.
  - While pressing the flapper against the disc, use your fingernail to help pull the hub through the disc from the other side.
6. Lubricate the o-ring sparingly with Krytox (do not get Krytox on the flapper).
7. Insert the flapper assembly into the ACGO outlet with the flapper up.
8. Replace the cap.

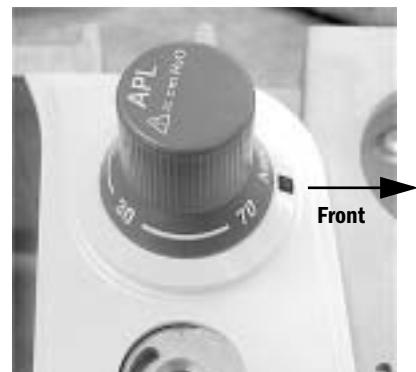


## 9.14 Replace the APL valve

1. Remove the ABS breathing system.
2. The APL valve is held in place with a spring and a retainer (**A**) that snaps into a recess in the lower body of the APL valve. To release the retainer, place an appropriately sized straight blade screwdriver into the housing cutout (**B**). Twist the screwdriver to release the retainer.

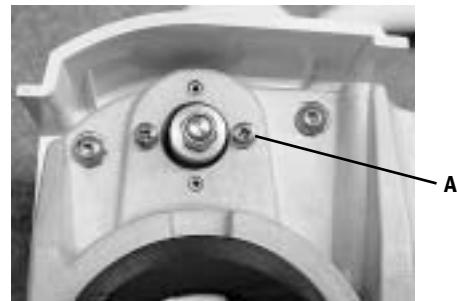


3. Place the new APL valve into position with the setting indicator facing to the front of the machine.
4. Place the spring into the retainer.
5. While holding the APL valve tight to the housing, Snap the spring and retainer onto the valve body from below.
6. Reinstall the ABS breathing system.
7. Perform the checkout procedure (Section 3).



## 9.15 Replace the bag support arm

1. Remove the ABS breathing system from the machine.
2. From the underside of the casting, remove the two screws/lockwashers (**A**) that hold the arm in place.



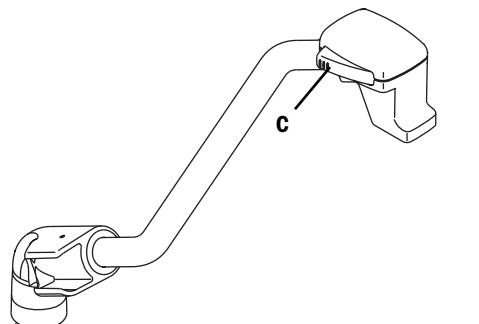
3. Install the new bag support arm assembly.

- Position the bag arm over mounting pattern of 4 small holes in the support casting. The arm should extend towards the front of the machine. Align the two pins (**B**) extending from the base of the bag arm assembly, with two of the small holes in the casting that are in line with the APL valve.
- Lower the bag arm, pushing the two pins into the holes.
- From the underside of the casting, secure the bag arm with two M3x16 screws and lockwashers.



4. Test the force required to swing the bag arm from side to side and adjust if necessary.

- Swing the bag arm sideways through the 90 degree arc permitted by its internal stop. The force required may be adjusted by turning the lock nut (8.5 mm socket) which is accessible from underneath the support casting. Turn clockwise to increase the force and counterclockwise to reduce the force.
- Adjust to just enough friction to prevent the bag arm from swinging sideways as the bag height is being changed. The bag arm height is changed by squeezing the lock release lever (**C**) at the free end of the bag arm and rotating it to the desired position.

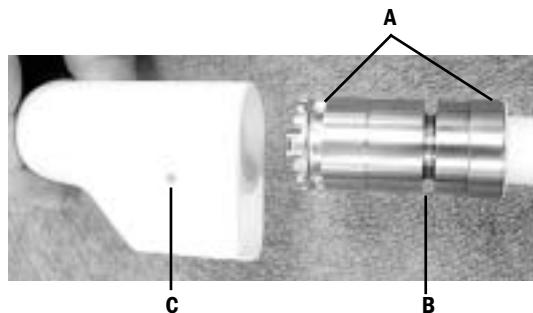
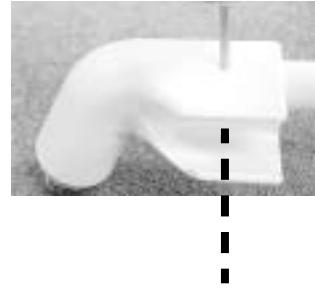


1. Replace the ABS breathing system.

### 9.15.1 Servicing the bag support arm

Service parts for the bag support arm include the upper and lower assemblies. Refer to Section 10.21.9. To replace either assembly:

1. Remove the bag support from the machine (Section 9.15).
2. To separate the upper assembly from the lower assembly, use a small (3 mm) pin punch to drive out the dowel pin that holds the assemblies together.
3. To assemble the bag arm, apply a light coat of Krytox to the area of the upper arm (**A**) that extends into the lower arm.
4. Insert the upper assembly into the lower assembly. Align the groove (**B**) with the dowel pin hole (**C**).

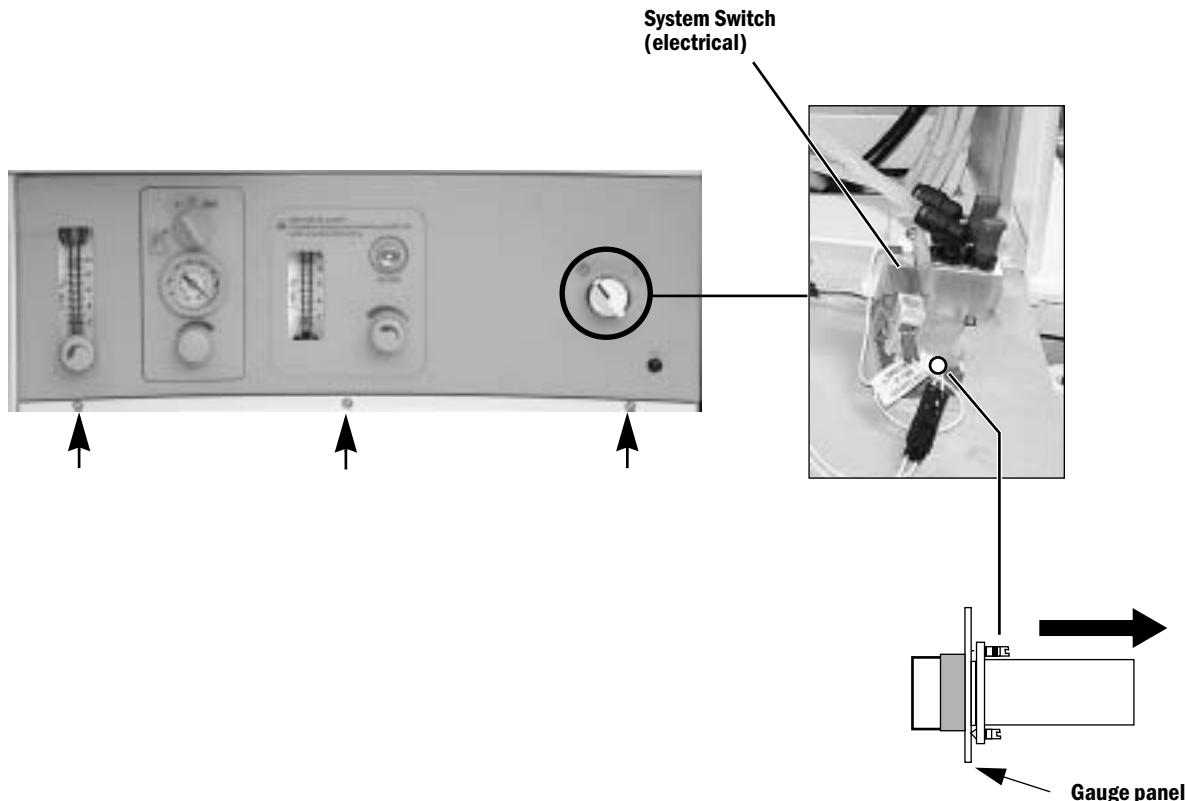


5. Insert the dowel pin into the hole (from the top side as shown). Drive the dowel pin into the bag arm until it is flush with the surface.



## 9.16 Replace system switch assembly

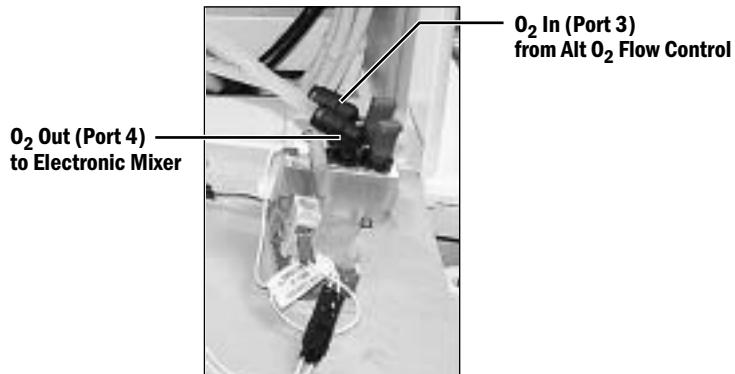
1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline pressures read zero before proceeding.
3. Remove the tabletop (Section 9.3).
4. Remove the gauge panel mounting screws and move the panel forward to access the system switch.



5. Disconnect the wires from the electrical switch.
6. Back out the system switch mounting screws just enough to allow the knob collar to be released.
7. While holding the switch assembly, push in the knob and turn it counterclockwise.
8. Pull the knob and collar out from the front and remove the switch assembly.

9. Install the replacement switch assembly:

- a. Transfer the 8-mm plugs from the old system switch to the new system switch on the pneumatic module (pull on the plug to ensure that it is locked into the module).
- b. Turn back the system switch mounting screws until their tips recede.
- c. Orient the switch assembly with the plugged fittings toward the right and the O<sub>2</sub> fittings toward the left.
- d. Install the switch assembly through the gauge panel.
- e. Push the knob collar in with the indicator up and turn it clockwise until it locks.
- f. Tighten the mounting screws. Make sure that the top edge of the switch assembly is parallel to the top edge of the gauge panel.
- g. Loosen the two outside screws on the electrical module.
- h. Insert the wires in the electrical module and tighten the screws.
- i. Pull the wires on the electrical module to ensure that there is a good connection.
- j. Transfer the tubing from the old system switch to the new system switch on the pneumatic module (pull on the tubing to ensure that it is locked into the module).



10. Test the replacement switch assembly:

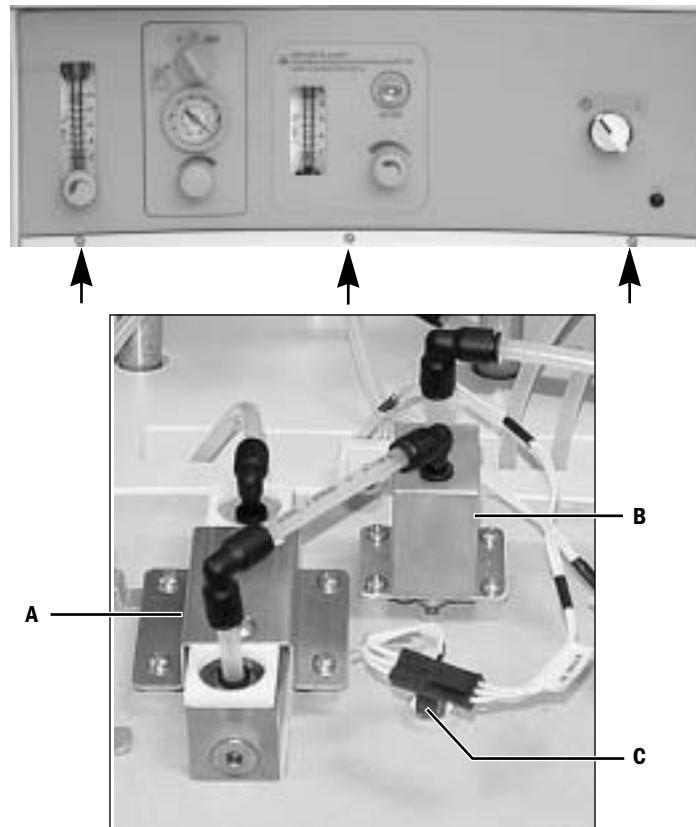
- a. Connect an O<sub>2</sub> supply.
- b. Connect the power cable to an electrical outlet.
- c. Set the system switch to On.
- d. Make sure that the display comes On.
- e. Select Alt O<sub>2</sub> flow.
- f. Increase the Alt O<sub>2</sub> flow. Make sure that gas flows.
- g. Make sure that you do not feel or hear any leaks.
- h. Set the system switch to Standby.
- i. Make sure all gas flow stops and the display turns Off.

11. Reinstall the gauge panel and the tabletop.

12. Perform the checkout procedure (Section 3).

## 9.17 Replace Alt O<sub>2</sub> components

1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline pressures read zero before proceeding.
3. Remove the tabletop (Section 9.3).
4. Remove the gauge panel mounting screws and move the panel forward to access the Alt O<sub>2</sub> components.



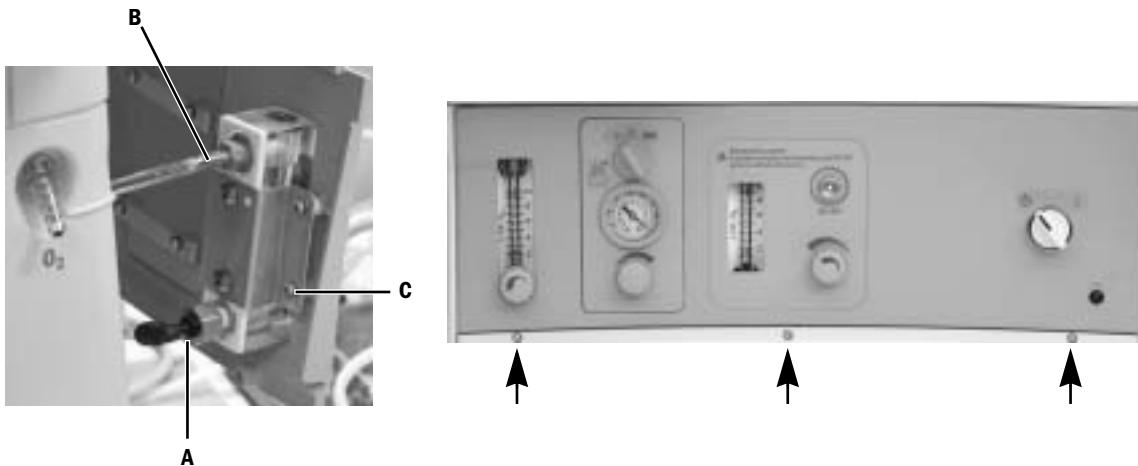
**Alt O<sub>2</sub> Flowmeter (A)** Disconnect the tubing from the flowmeter.  
Remove the four screws that hold the flowmeter mounting bracket to the front panel.  
Transfer the mounting bracket to the new flowmeter.

**Needle Valve Assembly (B)** Loosen the set screw that holds the knob to the needle valve; remove knob.  
Disconnect the tubing from the needle valve assembly.  
Remove the four screws that hold the needle valve assembly to the front panel.  
Transfer the mounting plate to the new needle valve assembly.

**Alt O<sub>2</sub> Switch (C)** Disconnect the switch harness.  
When replacing the switch, face the tab on the washer toward the switch body (tab not used for positioning).

## 9.18 Replace auxiliary O<sub>2</sub> flowmeter

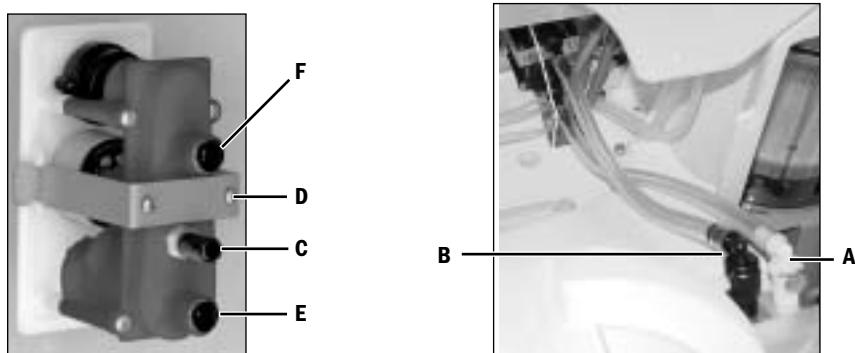
1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. Remove the tabletop (Section 9.3).
4. Remove the adjustment knob from the flowmeter; pull forward.
5. Remove the gauge panel mounting screws and move the panel forward to access the flowmeter.



6. Disconnect the inlet tube fitting (A).
7. Disconnect the tube (B) from the outlet fitting.
8. Remove the four screws (C) that hold the flowmeter mounting bracket to the front panel.
9. Transfer the mounting bracket to the new flowmeter.
10. Reassemble in reverse order.
11. Perform the checkout procedure (Section 3).

## 9.19 Replace the suction regulator

1. Lower the upper rear panel (Section 9.2).
2. Disconnect the white vacuum (**A**) and black suction (**B**) fittings from the rear panel.  
Do not remove the tubing from the regulator.
3. If you are replacing a Venturi Drive regulator, disconnect the tube (**C**) from the control port of the regulator assembly.



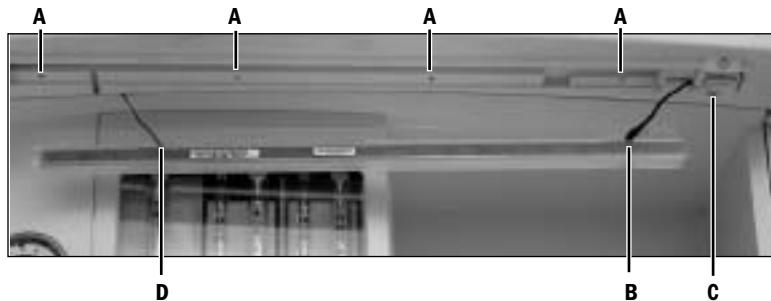
4. Disconnect the two screws (**D**) that hold the regulator assembly to the mounting bracket.
5. Remove the regulator assembly from the front panel.
6. Transfer the tubing to the new regulator:
  - Attach the vacuum source tube (white fitting) to the lower connector (**E**).
  - Attach the suction tube (black fitting) to the upper connector (**F**).
7. Guide the tubes into the front panel opening.
8. While holding the regulator assembly against the front panel, attach the retaining bracket to the regulator. Tighten the screws to secure the regulator assembly.
9. If applicable, attach the control port tube to the regulator assembly (**C**).
10. Attach the vacuum and suction fitting to the rear panel manifold.
11. Replace the rear panel.
12. Perform the checkout procedure (Section 3).

## 9.20 Replace task light components

The Avance machine includes two task lights (upper and lower) that are controlled by a common switch. The task light switch and the upper task light are accessible from the front of the machine. To service the lower task light you have to remove the rear panel.

### 9.20.1 To replace the task light switch

1. Remove the four screws (**A**) that hold the task-light lens to the upper shelf.



2. Using a small needle-nose pliers, disconnect the switch harness from the task-light circuit board connector (**B**).
3. Remove the two screws (**C**) that hold the switch retainer plate to the upper shelf.
4. Transfer the switch retainer plate to the new switch, counter-sunk side to the outside.
5. Mount the switch to the upper shelf.
6. Remount the task-light assembly. Ensure that the switch harness and the task-light harness wires are positioned in their respective recesses and are not pinched under the task-light lens.

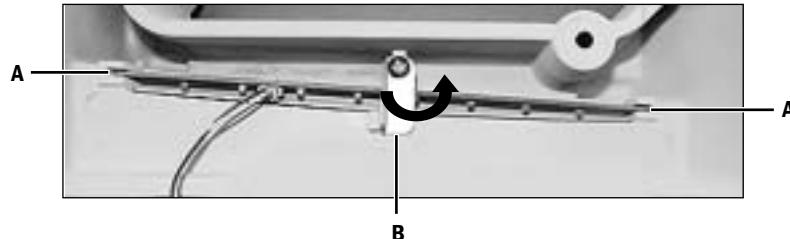
### 9.20.2 To replace the upper task light

1. Using a small needle-nose pliers,
  - disconnect the switch harness from the task light circuit board connector (**B**).
  - disconnect the task-light harness from the task light circuit board connector (**D**).
2. Slide the task-light circuit board out of the lens.
3. Slide the new task light into the lens, ensuring that the connectors are aligned with the lens cutouts.
4. Plug the task-light harness and the switch harness into their respective connectors on the task-light circuit board. Use a small screwdriver to push the connectors securely into place.
5. Remount the task-light assembly. Ensure that the switch harness and the task-light harness wires are positioned in their respective recesses and are not pinched under the task-light lens.

### 9.20.3 To replace the lower task light

1. Remove the rear panel (Section 9.2.1).

The lower task light is located directly below the MGAS partition. It slides into two slots in the front bezel (**A**) and is retained with a small moveable bracket (**B**).



2. Rotate the retaining bracket counterclockwise to free the task light assembly.
3. Disconnect the harness from the task light assembly and connect it to the new task light.
4. Place the task light into the slots (lights pointing down).

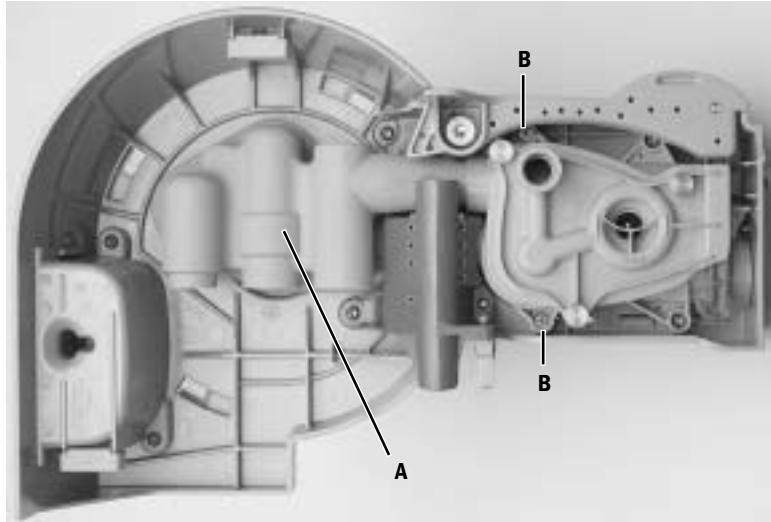
**Note** If the machine includes an integrated suction regulator, it may be too cramped for you to place the task light. Use long-nose pliers or a similar tool to guide the task light in place, being careful not to damage the lights. Or you can temporarily remove the suction regulator to gain more room.

5. Rotate the bracket in place to retain the task light.
6. Reassemble in reverse order.

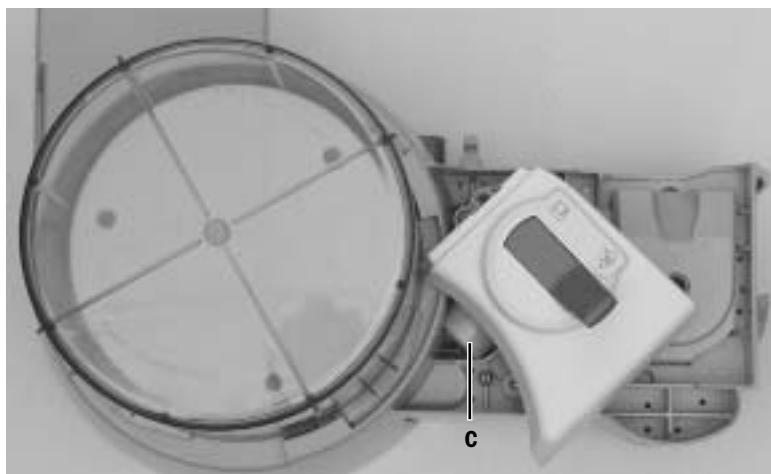
## 9.21 Replace ABS breathing system components

### 9.21.1 Replace Bag/Vent switch assembly

1. Remove the ABS breathing system.
2. From the underside, remove the bellows base manifold (**A**) and fully loosen the two captive screws (**B**) at the bag port side of the APL/BTV manifold.



3. From the topside, rotate the Bag/Vent switch cartridge counterclockwise until the Bag/vent switch outlet port (**C**) clears the bellows housing.

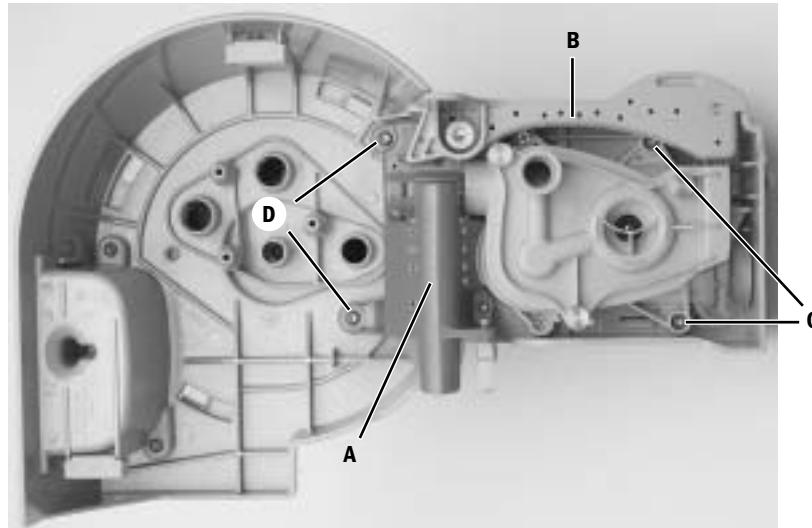


4. Lift out the Bag/Vent switch cartridge from the housing.
5. Replace the Bag/Vent switch cartridge in reverse order.
6. Reinstall the ABS breathing system.
7. Perform the checkout procedure (Section 3).

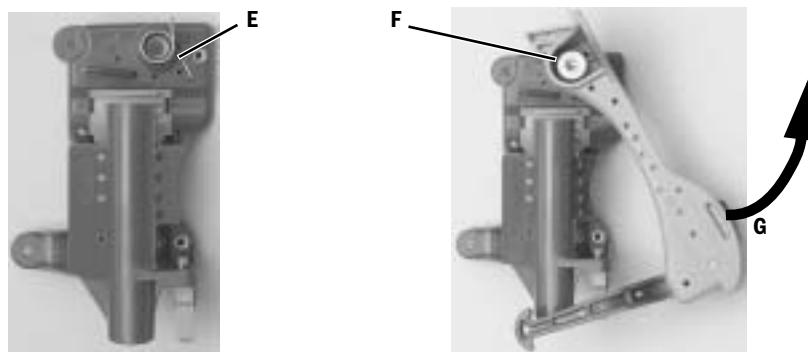
### 9.21.2 Replace bellows base latch assembly

To replace the latch assembly, you must disassemble the bellows base assembly to the point where you can remove the guide (**A**) and latch assembly (**B**) as a unit.

1. Remove the Bag/Vent switch cartridge (Section 9.21.1).
2. Remove the two remaining screws (**C**) that hold the APL/BTV manifold to the bellows base assembly. Remove the APL/BTV manifol.



3. To remove the guide/latch assembly, remove two mounting screws (**D**) from the underside. Remove two additional mounting screws from the topside. Remove the guide/latch assembly from the bellows base assembly.
4. Separate the latch assembly from the guide assembly.
5. To install the new latch assembly, put the spring (**E**) into place in the guide assembly (long leg down).
6. Place the latch assembly on the guide assembly so that the latch engages the short leg of the spring. Secure the latch assembly (**F**) to the guide assembly.



7. Mount the guide/latch assembly into the bellows base assembly.
  - Extend the latch (**G**) while placing the assembly into the base.
8. Reassemble the breathing system in reverse order.
9. Perform the checkout procedure (Section 3).

## 9.22 Replace casters

**⚠ WARNING** Replacing a caster requires at least two people to maneuver and tip the machine. Personal injury and/or machine damage is possible if one person attempts this procedure alone.

1. Disconnect all pipeline hoses from the wall and the machine, close all gas cylinders, unplug the power cord, and set the system switch to standby.

**⚠ CAUTION** Remove the vaporizers before tipping the machine. If a vaporizer is inverted, it must be set to 5% and purged for 30 minutes with a 5 L/min flow. The interlock system prevents purging more than one vaporizer at a time.

2. Remove the absorber, the vaporizers, gas cylinders, drawers and all auxiliary equipment.

**⚠ CAUTION** To prevent damage, do not tip the Avance machine more than 10 degrees from vertical.

3. Block the opposite wheels; then, block up the machine until there is enough room to remove the defective caster.

To block up the machine, tip and slide blocks under the caster base. Raise both sides evenly until the unit is high enough to remove the caster.

4. The casters are threaded into the base and held with a Loctite compound.

Remove the caster with an appropriately sized open-end wrench.

5. If required, clean the treads of the new caster with denatured alcohol.

6. Apply Loctite 242 to the threads of the new caster. Install the caster securely into place.



7. Make sure the caster turns freely.

8. Carefully lower the machine to the floor.

9. Perform the checkout procedure (Section 3).

## 9.23 Reconfigure sample gas return line

Sample gas return is directed to the scavenging system as a factory default. Perform the following to reroute the sample gas back to the breathing system. Refer to “Tubing” on page 11-10.

1. Remove the tabletop (Section 9.3).
2. Port 4 (**A**) of the ABS breathing system is connected to the expiratory circuit, downstream of the expiratory check valve. As a factory default, Port 4 is plumbed with a length of tubing that is plugged (**B**) at the far end.
3. Remove the plug from the tube.
4. Find the sample return line at the left-rear corner of the pan assembly. The sample return line includes an inline connector (**C**) at the point where the sample line goes down into the vent engine housing.
5. Separate the scavenging tube, removing the inline connector from the portion of the tube that extends into the vent engine housing. Plug the open end of the scavenging tube with the plug removed in step 3.
6. Insert the inline connector from the sample return port into the open tube to Port 4. Pull on the connector to ensure that it is securely connected.
7. Replace the tabletop.
8. Perform the checkout procedure (Section 3).



## 9.24 Change drive gas



**CAUTION** If you change the drive gas, you must also change the drive gas selection on the ventilator service setup screen. Refer to Section 4 of the ventilator Technical Reference manual.

- If the drive gas selection and the actual drive gas do not agree, volumes will not be correct.

The ventilator will alarm with the message “Low Drive Gas Press” if the selected drive gas pressure, either O<sub>2</sub> or Air, is lost.

1. Remove the rear panel (Section 9.2).

**Note:** The O<sub>2</sub> and Air pipeline manifolds have a drive gas connection at the back. The connection not in use is plugged.

2. Remove the plug from the new connection.
3. Disconnect the drive gas hose from the present connection.
4. Install the plug in this connection (pull on the plug to ensure that it is locked into the fitting).
5. Reroute the drive gas hose so that it does not cause kinks in other tubing.
6. Connect the drive gas hose to the new connection (pull on the hose connector to ensure that it is locked into the fitting).
7. Do a high-pressure leak test (Section 3.5).
8. Enter the service mode and select the correct drive gas.
9. Test the primary regulator. Verify that it functions within specifications now that it will be supplying drive gas to the ventilator (Section 5.1).
10. Perform the checkout procedure (Section 3).

## Notes

# 10 Illustrated Parts

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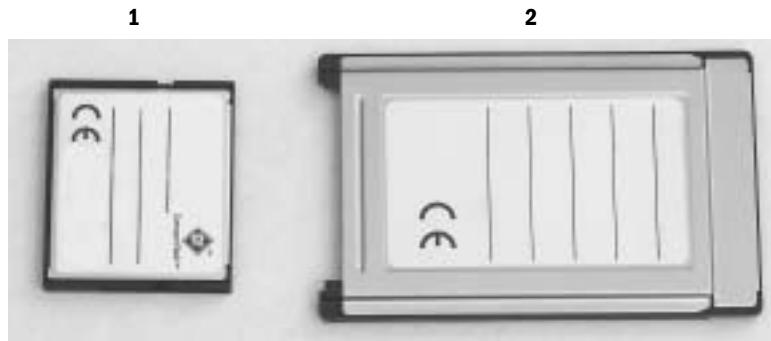
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## 10.1 Service tools

### 10.1.1 Software tools

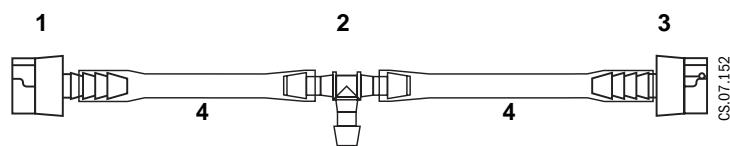
Item	Description	Stock Number
1	Service Application/System Software 1.2 (on Compact Flash card)	1009-5914-000
2	Compact Flash Adapter, PCMCIA carrier	1009-5874-000



### 10.1.2 Manifold pressure test adapter

The manifold pressure test adapter is used to tee into the manifold pressure line for the Manifold P Span calibration (Section 5.4.2).

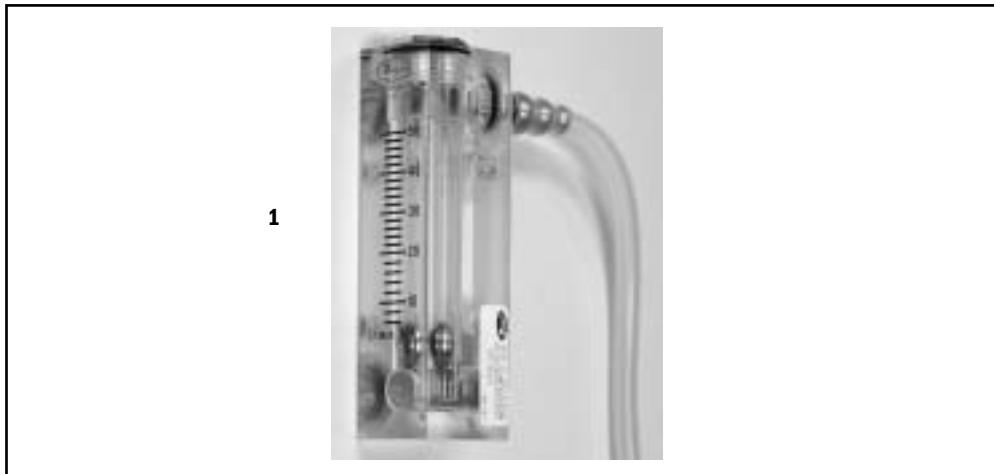
Assemble the adapter using the parts shown.



Item	Description	Stock Number
1	Coupler, male - white	1503-3236-000
2	Tee (male barb)	1009-3011-000
3	Coupler, female - white	1503-3119-000
4	Tubing (low-pressure) 1/4 inch	1605-1001-000

### 10.1.3 Test Devices

Item	Tool	Stock Number
1	Test flowmeter, 6–50 L/min (Suction Flow Test)	1006-8431-000



#### Not Shown

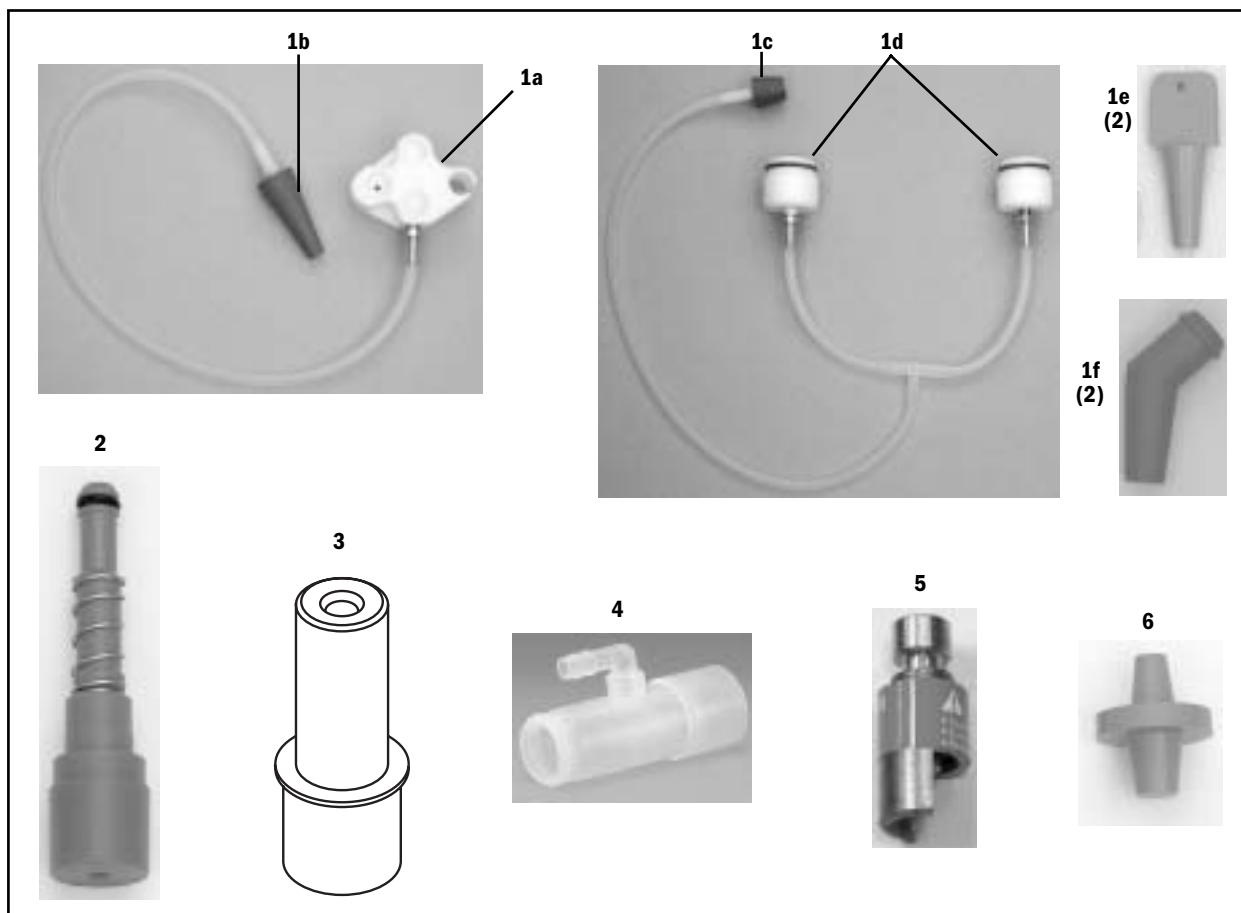
Low-pressure Leak Test Device	(negative pressure)	0309-1319-800
Low-pressure Leak Test Device	(positive pressure - ISO)	1001-8976-000
Low-pressure Leak Test Device	(positive pressure - BSI)	1001-8975-000
Flow test device capable of measuring 0–15 L/min with an accuracy of $\pm 2\%$ of reading		Refer to section 6.6
Vacuum test gauge capable of measuring 0 to 550 mm Hg with an accuracy of $\pm 1\%$ of reading		Refer to section 6.8
Test device capable of measuring 0–30 L/min (see Item 1 above)		Refer to section 6.8
Leakage current test device		Refer to section 3.13
Test device capable of measuring 689 kPa (100 psi)		Refer to section 5.1.1

### 10.1.4 Lubricants and Adhesives

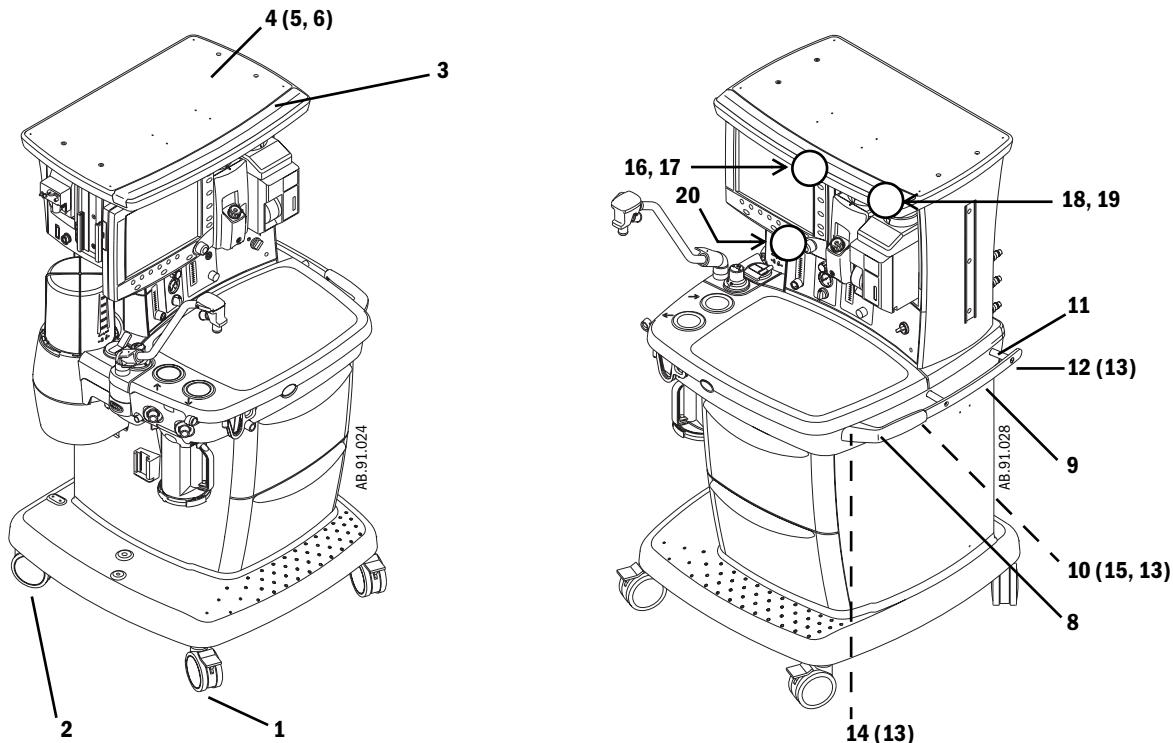
Item	Description	Stock Number
1	Lubricant, Krytox GPL 205, 2 oz	1001-3854-000
2	Lubricant, Dow 111, 5.3 oz	6700-0074-200
3	Thread Lock, Loctite No 24221, 10 ml	0220-5017-300
4	“Super Glue Gel”, Loctite 454	6812-2160-010

### 10.1.5 Test Tools

Item	Tool	Stock Number
1	Leak Test Tool Kit, ABS breathing system	1407-7013-000
1a	Test Tool, bulkhead	1407-8500-000
1b	Plug, tapered 27x12 mm	1407-8505-000
1c	Plug, tapered 24x18 mm	1407-8506-000
1d	Test Tool, circle module (2 each)	1407-8502-000
1e	Plug, service B/S 11 mm (2 each)	1407-8504-000
1f	Plug, service BTV 18 mm (2 each)	1407-8503-000
2	Adapter, positive low-pressure leak test	1009-3119-000
3	PEEP/INSP Calibration Flow Orifice	1504-3016-000
4	Airway Pressure Sensing Tee	1504-3011-000
5	Vaporizer Manifold Valve Test Tool	1006-3967-000
6	Plug, stopper	2900-0001-000
<b>Not Shown</b>		
	Tool to help disconnect tubing from Legris fittings	2900-0000-000
	Test Lung	0219-7210-300
	Leak detection fluid, Snoop	obtain locally

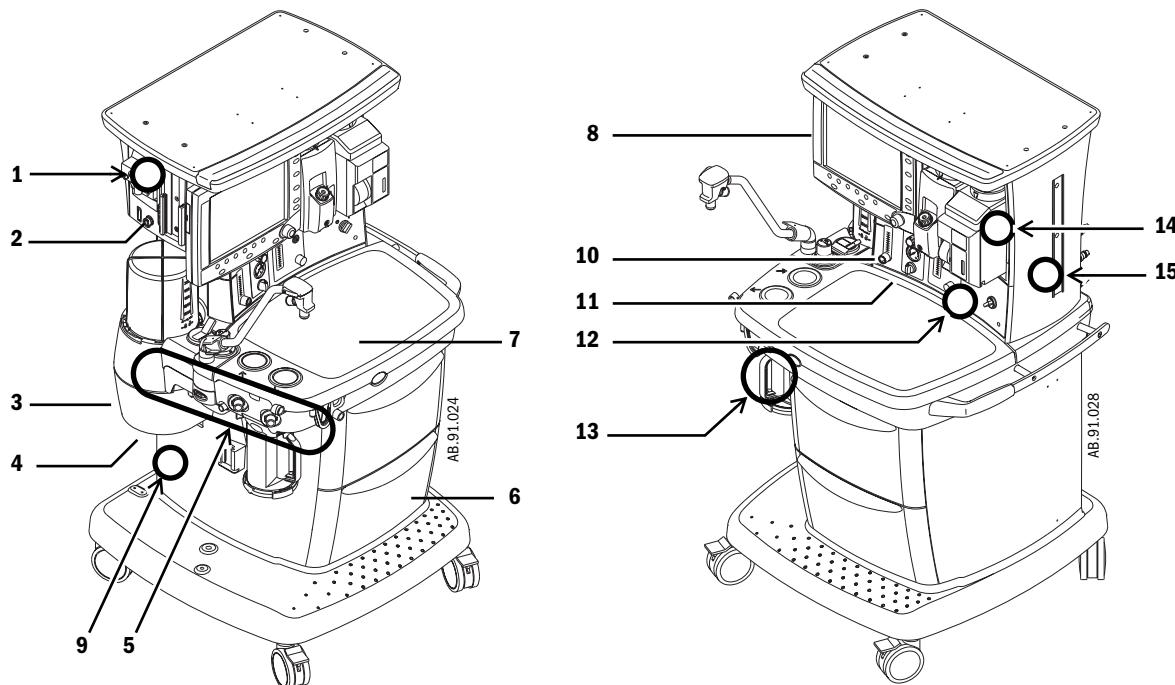


## 10.2 External components - front view



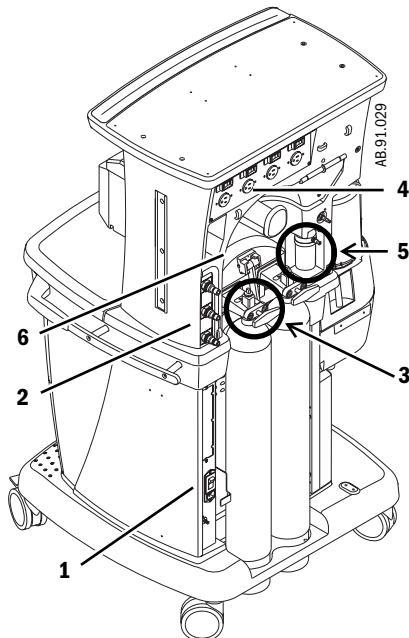
Item	Description	Stock Number
1	Caster, 125-mm with brake (front)	1006-3070-000
2	Caster, 125-mm no brake (rear)	1006-3071-000
3	Cover, cable channel	1009-3020-000
4	Upper shelf	1009-3022-000
5	Bolt, M6x40	0144-2131-911
6	Lockwasher, M6 internal	0144-1118-130
8	Handle, side	1009-3033-000
9	Handle, Medirail	1009-3101-000
10	Screw, M6x12 Sems	0144-2436-106
11	Spacer	1009-3102-000
12	Screw, M6x70	0144-2131-923
13	Lockwasher M6 external	9213-0560-003
14	Screw, M6x20	0144-2131-921
15	Shim	1009-3131-000
16	Task Light PCB, Upper	1009-5504-000
17	Lens, Task Light	1011-3308-000
	Screw	0142-4254-106
18	Switch Assembly, task light	1009-5587-000
19	Plate, switch mounting retainer	1009-3143-000
	Screw	0140-6226-107
20	Task Light PCB, Lower	1009-5857-000

## 10.3 External components - front view references



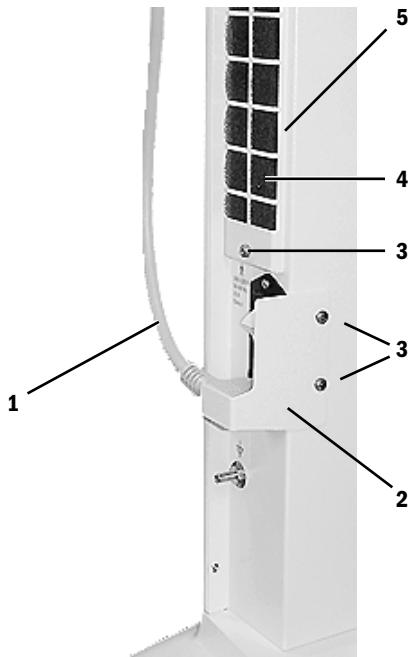
Item	Description	Section number
1	"Airway module (MGAS) components"	Refer to section 10.23.1
2	"AGSS gauge, and sample return"	Refer to section 10.23
3	"Vent Engine Housing"	Refer to section 10.14
4	"Anesthetic Gas Scavenging System – AGSS"	Refer to section 10.22
5	"Breathing System"	Refer to section 10.21
6	"Drawer"	Refer to section 10.30
7	"Tabletop components"	Refer to section 10.27
8	"Display Unit"	Refer to section 10.7
9	"External components - lower assembly"	Refer to section 10.29
10	"Auxiliary O <sub>2</sub> Flowmeter"	Refer to section 10.25
11	"Integrated Suction Regulator"	Refer to section 10.24
12	"Front panel, Alt O <sub>2</sub> , and system switch"	Refer to section 10.19
13	"ABS to machine Interface Components (SCGO)"	Refer to section 10.16
14	"Vaporizer manifold"	Refer to section 10.13
15	"Right-side Components"	Refer to section 10.28

## 10.4 External Components - rear view



Item	Description	Stock Number
1	AC Inlet	Refer to section 10.5
2	Pipeline Inlets Label, pipeline inlet blank	Refer to section 10.11 1009-3197-000
3	Cylinder Gas Supplies	Refer to section 10.12
4	Electrical Power Outlet	Refer to section 10.6
5	Suction items	Refer to section 10.24
6	Rear panel items	Refer to section 10.26

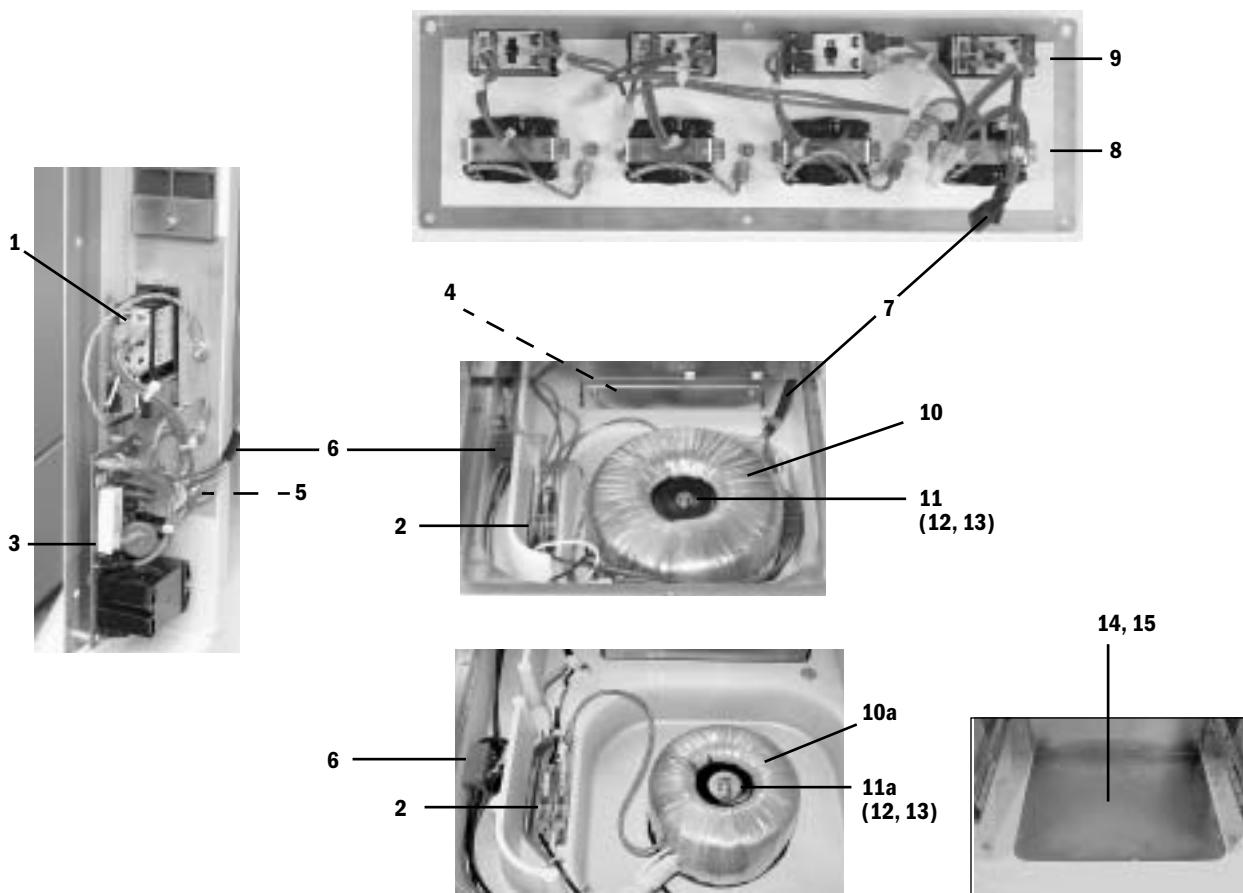
## 10.5 AC Power cords and AC Inlet filter



Item	Description	Stock Number
1	Power Cord	
	Australia and China, 220-240 VAC AS 3112 outlets	1006-3888-000
	EURO and France, 220 VAC with CEE 7/7	1001-3380-000
	India and South Africa, 220-240 VAC BS546	1006-3885-000
	Japan and US, 100-120 VAC NEMA	1006-3907-000
	Swiss, 220-240 VAC SEV 1011	1006-3889-000
	UK, 220-240 VAC BS1363	1006-3884-000
2	Clamp, power cord retainer	1009-3103-000
3	Screw, M4x8 Pozidriv	0140-6226-113
4	Filter, foam	1009-3064-000
5	Retainer, filter	1009-3058-000

## 10.6 AC Inlet/Outlet Components

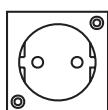
<b>Item</b>	<b>Description</b>	<b>Stock Number</b>
1	Inlet, 100/120 AC, with line filter and 15 A circuit breaker Inlet, 220/240 AC, with line filter and 8 A circuit breaker	1009-5698-000 1009-5757-000
2	Fuse, 5A - 5x20mm Fuse holder	1009-5779-000 1009-5674-000
3	Circuit board, Inrush, 100-120V Circuit board, Inrush, 220-240V	1006-3245-000 1006-3246-000
4	Filter, AC Line, 6VW1, 100-240V	1009-5690-000
5	Stud, Equal Potential, 6 mm	0208-0070-300
6	Harness, 100/120 V to Toroid Harness, 220/240 V to Toroid	1009-5752-000 1009-5753-000
7	Harness, to 100/120 V outlets Harness, to 220/240 V outlets	1009-5716-000 1009-5717-000
8	Outlet Receptacle, Australia, AS 3112 Outlet Receptacle, EURO, CEE 7/7 Outlet Receptacle, France, CEE 7/4 Support Frame, snap in Outlet Receptacle, India and South Africa, BS 546 Outlet Receptacle, Japanese Outlet Receptacle, NA, Nema 5-15 Outlet Receptacle, Swiss, SEV 1011 Outlet Receptacle, UK, BS1363	1001-3305-000 1202-3551-000 1006-4421-000 1006-4422-000 1006-3805-000 1006-3578-000 1006-3555-000 1006-3807-000 1001-3309-000
9	Circuit Breaker, 1A, Rocker Circuit Breaker, 2A Rocker Circuit Breaker, 3A Rocker Circuit Breaker, 4A Rocker	1009-5722-000 1009-5721-000 1009-5720-000 1009-5719-000
10	Toroid, 100-240V	1009-5692-000
10a	Toroid, 100-240V - used with no outlets	1009-5758-000
11	Screw, M6x70	0144-2131-923
11a	Screw, M6x60	0144-2131-914
12	Lockwasher, M6	9213-0560-003
13	Washer	0402-1107-500
14	Cover, transformer	1009-3063-000
15	Screw, M4x8 DIN84 (for transformer cover)	1006-3178-000



Australia/China, AS 3112  
1001-3305-000

AA.96.228

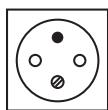
Japanese  
1006-3578-000



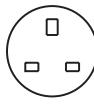
EURO, CEE 7/7  
1202-3551-000



Swiss, SEV 1011  
1006-3807-000



France, CEE 7/4  
1006-4421-000



UK, BS1363  
1001-3309-000



India and South Africa, BS 546  
1006-3805-000



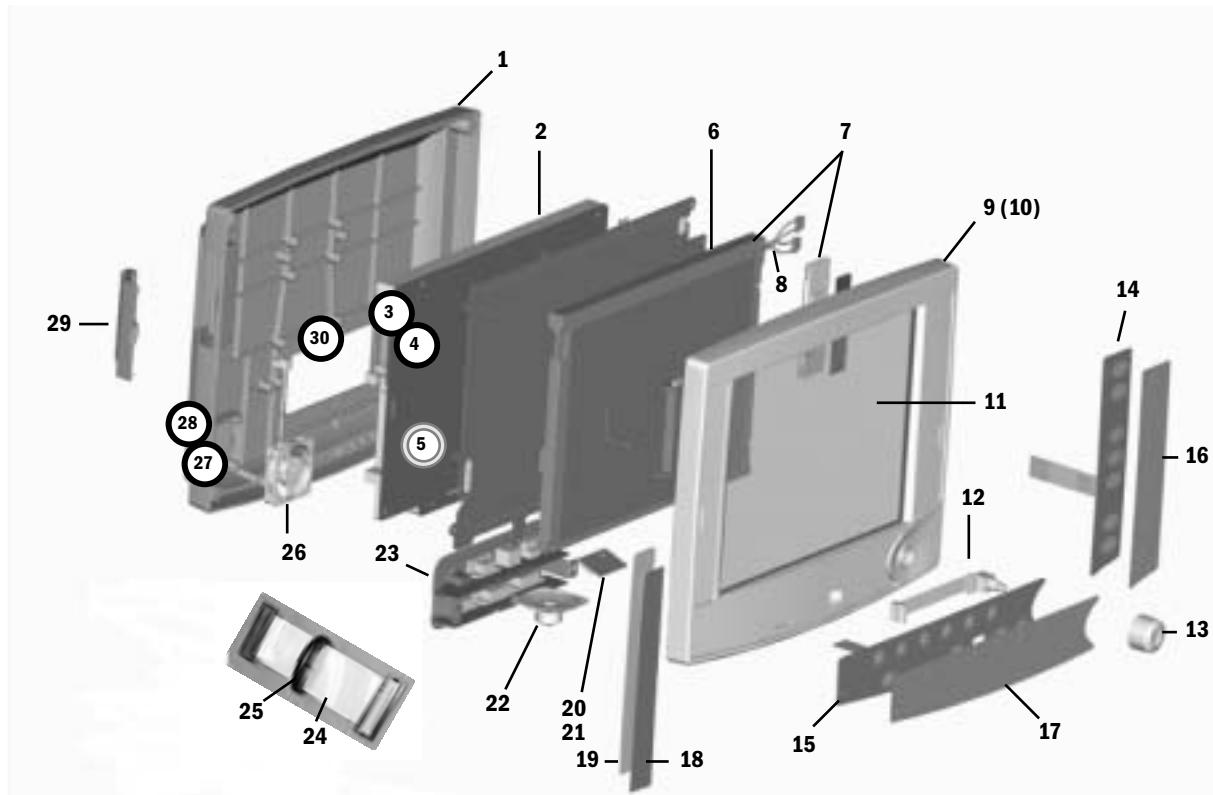
NA, Nema 5-15  
1006-3555-000

## 10.7 Display Unit

<b>Item</b>	<b>Description</b>	<b>Stock Number</b>
	Display Assembly, complete, without keypads	1009-8224-000
1	Enclosure, rear	1009-5673-000
2	CPU Board, display unit (with PCMCIA frame)	1009-8289-000
3	Frame, PCMCIA	1009-5761-000
4	Gasket, knife edge (2 each)	1009-5804-000
5	Battery, Lithium 3V (positive side up)	1009-5800-000
6	Display, LCD 12-inch color (includes backlights)	1009-5693-000
7	Backlight Kit (backlight assembly, 2 inverters, and hardware)	1009-8243-000
7a	Inverter, backlight	1009-5694-000
7b	Harness, inverter	1009-5527-000
7C	Spacer, 8mm Nylon	1009-5695-000
8	Grommet, diagonal cut (backlight cable)	1009-3152-000
9	Enclosure, front	1009-5672-000
10	Gasket, EMC 1.8mm OD hollow RND (2.3 m per enclosure)	1009-5802-000
11	Window	1009-5676-000
12	Encoder assembly	1503-3012-000
13	Knob, ComWheel	898794
14*	Membrane switches, right	1009-5505-000
15*	Membrane switches, lower	1009-5507-000
16*	Keypad, right-side (part of keypad set)	Refer to Table 1
17*	Keypad, lower (part of keypad set)	Refer to Table 1
18*	Keypad, blank (part of keypad set)	Refer to Table 1
19	Spacer, blank keypad	1009-5870-000
20	IRDA Interface Board	1009-5773-000
21	Harness, CPU to IRDA	1009-5799-000
22	Speaker assembly, 8-ohm	1605-3263-000
23	Rear Connector Panel Assembly (with interface boards)	1009-8244-000
24	Cable, ribbon CPU to Display	1009-5520-000
25	Grommet	1009-3151-000
26	Fan, 5Vdc	1504-3516-000
27	Capsule, fan filter	896089
28	Filter, fan	897010
29	Door, PCMCIA	1009-5679-000
30	Gasket, cover plate	1009-5678-000
41**	Screw, M3x6 Sems	0140-6219-128
42	O-ring	1009-3306-000
43**	Screw, M4x8 Sems	0140-6226-113
44**	Screw, M4x12 relieved body	1504-3001-000
45**	Lockwasher, M4 external	9213-0540-003
46**	Screw, M3x16	1504-3003-000
47**	Lockwasher, M3 external	9213-0530-003
48**	Screw, M3x6 Nylon	9211-1730-065
49**	Screw, M2x16	0140-6216-100

\* Keypads will likely be damaged during membrane switch replacement; order parts accordingly.

\*\* Refer to Table 2 for where used.

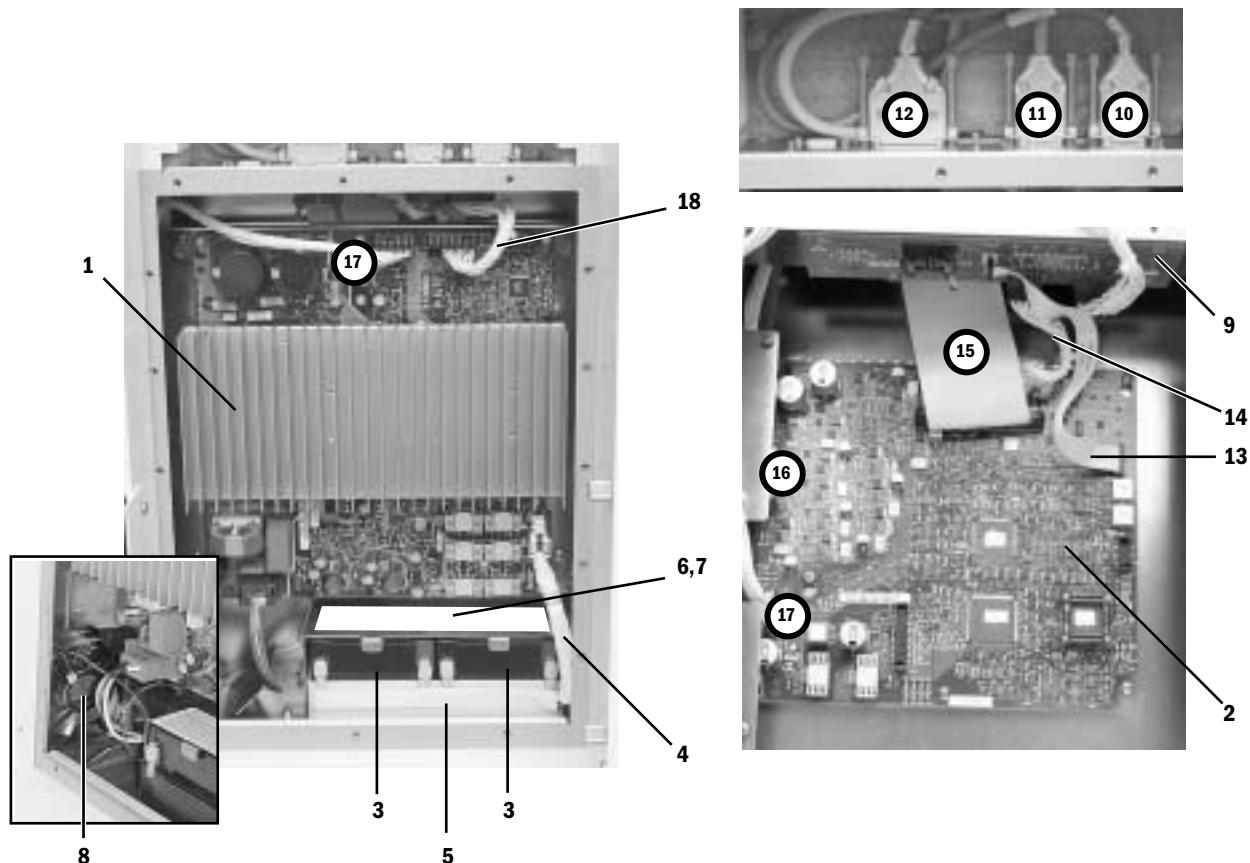
**Table 1:**

<b>Language</b>	<b>Keypad Set</b>
Chinese	1009-5932-000
Czech	1009-5923-000
Danish	1009-5931-000
Dutch	1009-5918-000
English	1009-5915-000
Finnish	1009-5922-000
French	1009-5916-000
German	1009-5917-000
Greek	1009-5927-000
Hungarian	1009-5928-000
Italian	1009-5919-000
Japanese	1009-5929-000
Norwegian	1009-5925-000
Polish	1009-5924-000
Portuguese	1009-5921-000
Russian	1009-5930-000
Spanish	1009-5920-000
Turkish	1009-5926-000

**Table 2:**

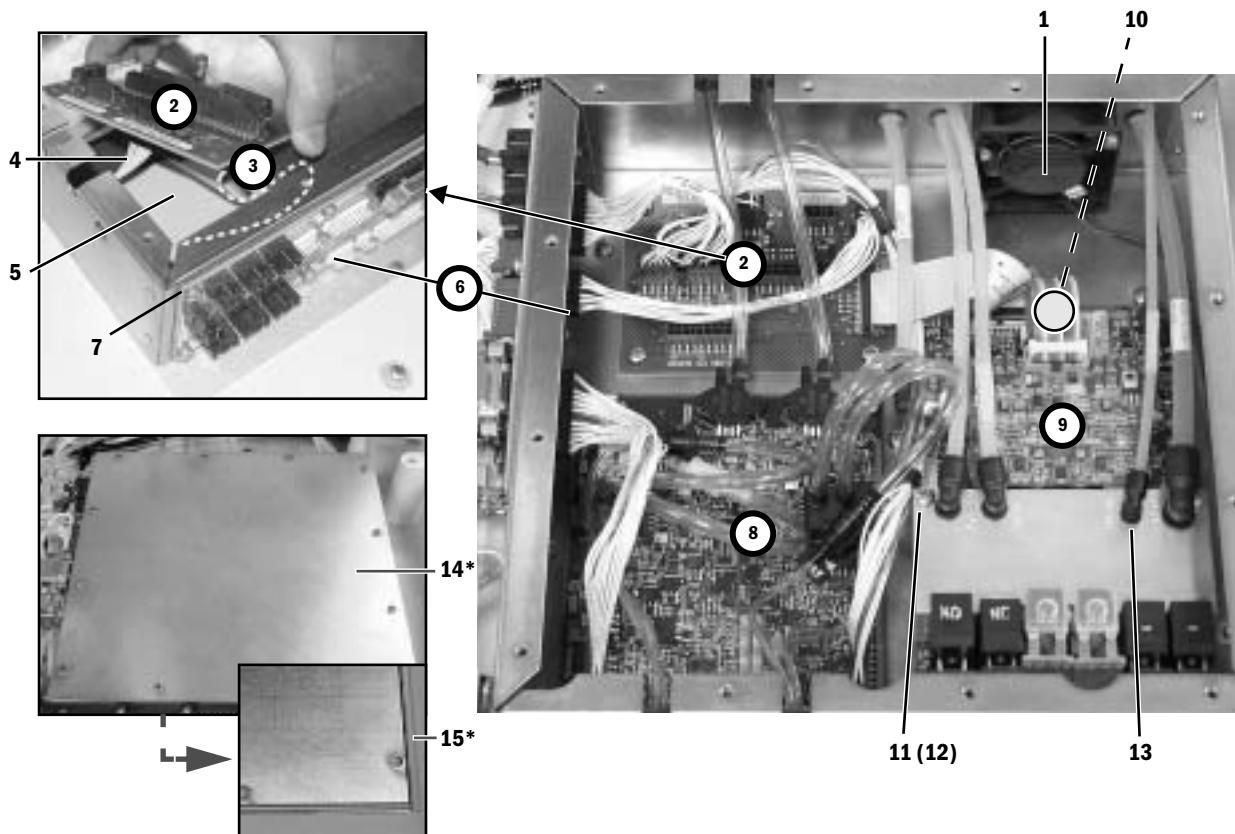
<b>Hardware Item where used (Qty)</b>
Speaker: 41(2)
IRDA board: 41(1), 42(1)
Door: 41(2)
CPU to plate: 43(4)
Rear connector panel assembly: 43(2)
Ground straps for keypads: 43(2)
Mounting plate to Front enclosure: 43(10)
Rear enclosure: 44(4), 45(4)
Fan: 46(4), 47(4)
Inverters: 48(4)
PCMCIA frame: 49(4)

## 10.8 Lower electronic enclosure components



Item	Description	Stock Number
1	Power Controller board (with mounting plate)	1009-8290-000
2	Anesthesia Control board (tested)	1009-8291-000
3	Battery, sealed lead acid, 12V 4AH	1009-5682-000
4	Harness, battery	1009-5557-000
5	Tray, battery	1009-3133-000
6	Bracket, battery restraint	1009-3060-000
7	Label, battery service instructions	1009-5530-000
8	Fan (flow into enclosure)	1009-5697-000
9	Display Connector Board	1009-3005-000
10	Cable, to Display Unit system power interface	1009-5571-000
11	Cable, to Display Unit system signal interface	1009-5572-000
12	Cable, to Airway Module power supply	1009-5555-000
13	Cable, ribbon J2-ACB to J9-DCB	1009-5561-000
14	Harness, J7-ACB to J6-DCB	1009-5556-000
15	Cable, ribbon J1-ACB to underside of Pan Connector Board	1009-5549-000
16	Harness, J3-ACB to underside of Pan Connector Board	1009-5560-000
17	Harness, J4-ACB to J4-PCB	1009-5551-000
18	Harness, J3-PCB to J5-DCB	1009-5552-000

## 10.9 Pan electronic enclosure components



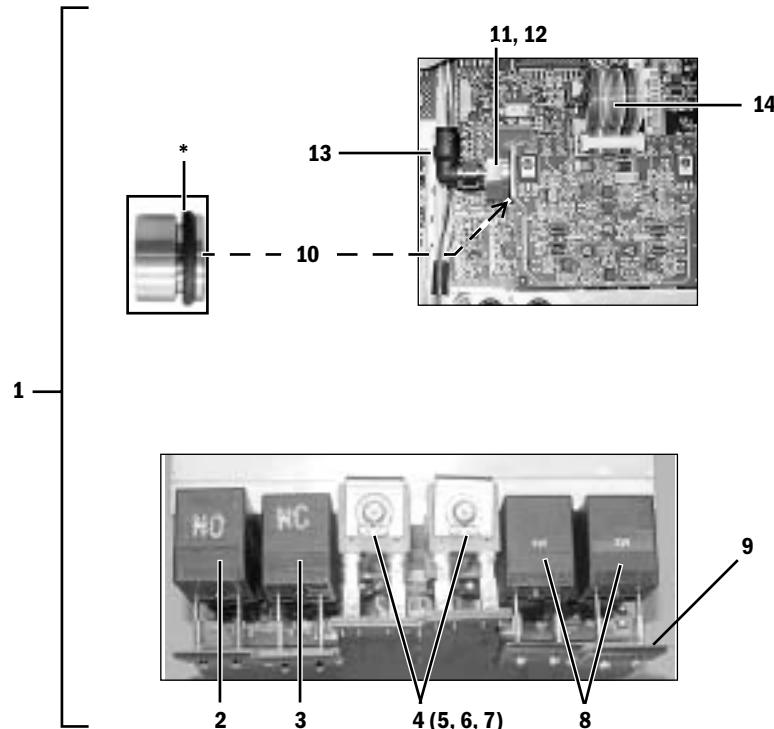
Item	Description	Stock Number
1	Fan (flow into enclosure)	1009-5680-000
2	Pan Connector Board	1009-3003-000
3	Gasket, Pan Connector Board	1009-5536-000
4	Harness, to J3-ACB	1009-5560-000
5	Cable, ribbon to J1-ACB (fold excess cable into pan area)	1009-5549-000
6**	Filter Board, ABS	1009-3007-000
7	Gasket, EMI 272 mm (2 each required per board)	1009-5811-000
8	Ventilator Interface Board, calibrated	1009-8236-000
9	Gas Mixer Assembly, complete	Refer to section 10.10
10	Screw, M4x6	1009-3283-000
11	Screw, M4x35	0140-6226-127
12	Lockwasher, M4 external	9213-0540-003
13	Plug, 4-mm (if no N <sub>2</sub> O)	1006-3530-000
14*	Cover, pan electronic enclosure	1009-3047-000
15*	Gasket, EMI electronic enclosure (4 required)	1009-5811-000

\* The top side of the cover has rounder edges. Apply the EMI gasket to the underside (sharp edges) of the cover.

\*\* Also requires Item 7, EMI gasket, two each.

## 10.10 Electronic Gas Mixer

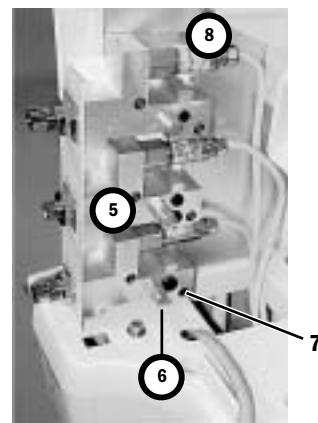
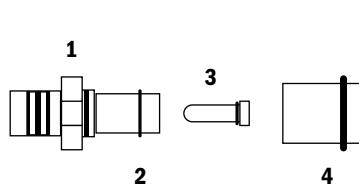
**⚠ CAUTION** Ensure a clean environment when servicing the gas mixer.



Item	Description	Stock Number
1	Mixer Assembly - complete	1011-8000-000
2	Valve, 2-way NO (includes screws and gasket)	1009-3014-000
3	Valve, 2-way NC (includes screws and gasket)	1009-3013-000
4	Valve, proportional	1011-3560-000
5	O-ring (2 used with each proportional valve)	6027-0000-165
6	Screw, M3x16 (2 used for mounting each valve)	0140-6719-103
7	Lockwasher, M3 external	9213-0530-003
8	Valve, 3-way NC (includes screws and gasket)	1009-3346-000
9	Flex-cable, valve interface	1009-3359-000
10	Outlet check valve, replacement kit (includes o-ring and flapper valve)	1009-8246-000
11	Retainer, flapper valve	1011-3516-000
12	O-ring, retainer	1011-3518-000
13	Elbow, 1/4 inch tube to 1/8 inch NPT	1011-3071-000
14	Cable, TSI interface	1011-3082-000

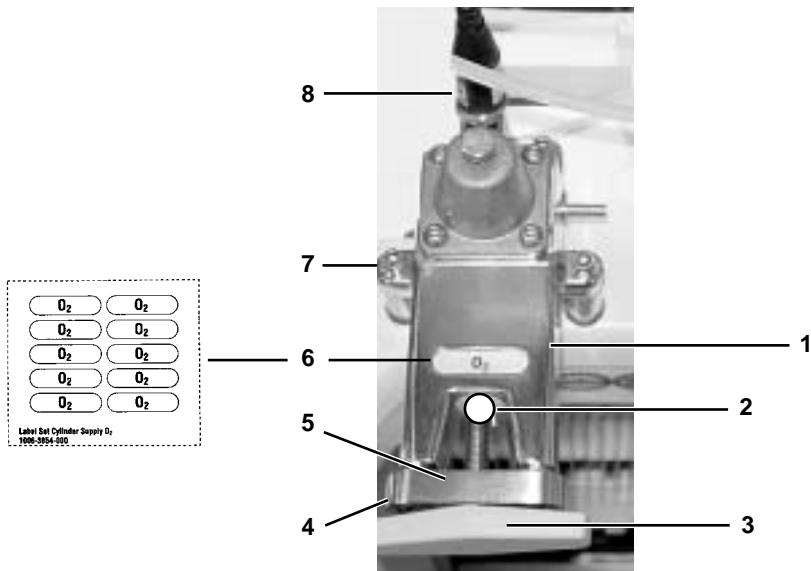
\* Lubricate sparingly with Krytox.

## 10.11 Pipeline inlet fittings



Item	Description	Stock Number
1	<b>Pipeline inlet - O<sub>2</sub> fittings</b>	-----
	Body, O <sub>2</sub> DISS	1006-5149-000
	Body, O <sub>2</sub> NIST	1006-5158-000
	Body, O <sub>2</sub> DIN	1006-5161-000
	Body, O <sub>2</sub> G 3/8 BSPP	1006-5170-000
	Pipeline inlet assembly O <sub>2</sub> France	1006-8363-000
	Pipeline inlet assembly O <sub>2</sub> Canada	1006-8360-000
	Pipeline inlet assembly O <sub>2</sub> Australia	1006-8396-000
1	<b>Pipeline inlet - N<sub>2</sub>O fittings</b>	-----
	Body, N <sub>2</sub> O DISS	1006-5150-000
	Body, N <sub>2</sub> O NIST	1006-5159-000
	Body, N <sub>2</sub> O DIN	1006-5162-000
	Body, N <sub>2</sub> O G 3/8 BSPP	1006-5171-000
	Pipeline inlet assembly N <sub>2</sub> O France	1006-8362-000
	Pipeline inlet assembly N <sub>2</sub> O Canada	1006-8359-000
	Pipeline inlet assembly N <sub>2</sub> O Australia	1006-8397-000
1	<b>Pipeline inlet Air fitting</b>	-----
	Body, Air DISS	1006-5151-000
	Body, Air NIST	1006-5160-000
	Body, Air DIN	1006-5163-000
	Body, Air G 3/8 BSPP	1006-5172-000
	Pipeline inlet assembly Air France (service kit)	1006-8361-000
	Pipeline inlet assembly Air Canada (service kit)	1006-8358-000
	Pipeline inlet assembly Air Australia (service kit)	1006-8398-000
2	O-ring, bore seal	-----
	O <sub>2</sub> and N <sub>2</sub> O	0210-0479-300
	Air	0210-0539-300
3	Sintered metal filter with o-ring	1006-8351-000
4	Pipeline check valve with o-ring	1006-3160-000
5	Gas Inlet Manifold (replacement)	-----
	O <sub>2</sub>	1009-8066-000
	N <sub>2</sub> O	1009-8067-000
	Air	1009-8068-000
6	Relief valve, 689/758 kPa (100/110 psi)	1011-3049-000
7	Screw, M4x20	0144-2124-218
	Lockwasher, M4	9213-0540-003
8	Transducer, pipeline pressure (includes cable)	1011-3000-000

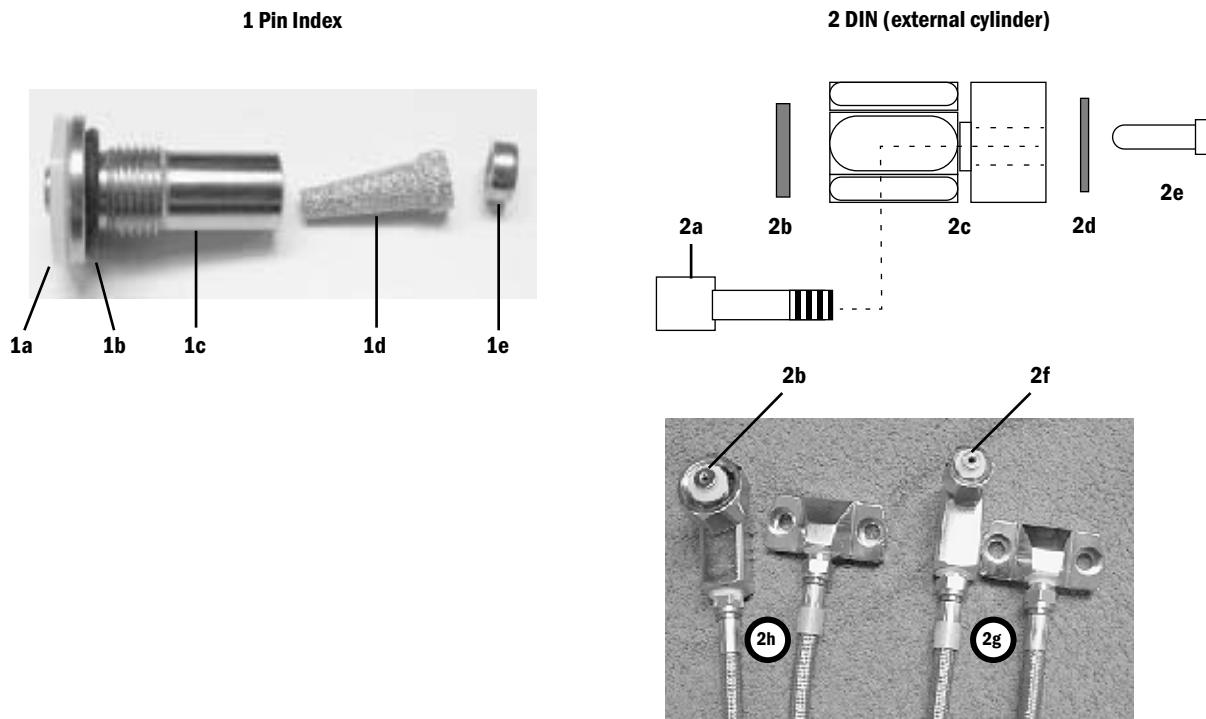
## 10.12 Cylinder Gas Supplies



Item	Description	Pin Index	DIN	DIN (Large Cylinder)
1	Gas supply O <sub>2</sub>	1006-3201-000	1006-3207-000	1006-3880-000
1	Gas supply N <sub>2</sub> O	1006-3202-000	1006-3208-000	1006-3881-000
1	Gas supply Air	1006-3203-000	1006-3209-000	-----

Item	Description	Stock Number
2	Cylinder inlets (Pin Index or DIN for external cylinder)	Refer to section 10.12.1
3	Tee handle beige	0219-3372-600
4	Spacer, gas block (2) Screw, M8 x 25 long socket head cap (2)	1001-4077-000 9211-0680-253
5	Clamp, yoke	1001-4076-000
6	Label Set, cylinder supply, O <sub>2</sub> Label Set, cylinder supply, N <sub>2</sub> O Label Set, cylinder supply, Air	1006-3854-000 1006-3855-000 1006-3856-000
7	Screw M6x25 socket head cap/ 3 per supply Lockwasher (for above screw) Internal M6	9211-0660-254 0144-1118-130
8	Transducer, cylinder pressure (includes cable)	1011-3001-000

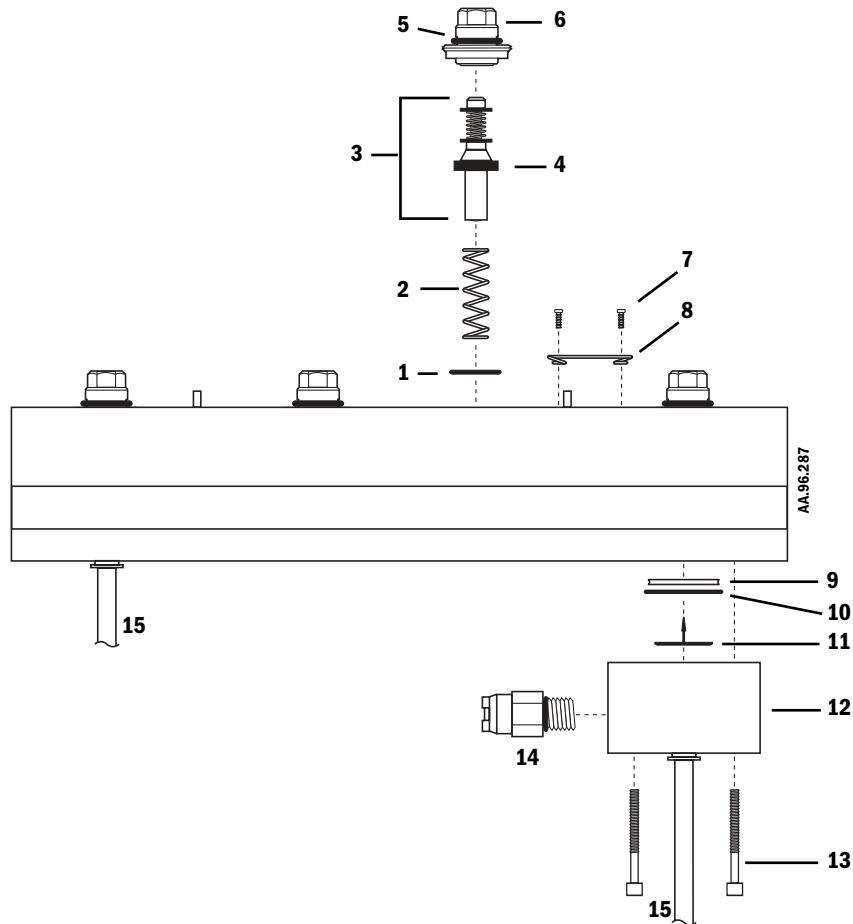
### 10.12.1 Cylinder inlet fittings



Item	Description	Stock Number
<b>1</b>	<b>Cylinder inlets (Pin Index)</b>	-----
1a	Gasket	0210-5022-300
1b*	O-ring	9221-3013-116
1c	Adapter, inlet	1001-4075-000
1d	Filter, sintered bronze	9914-6380-000
1e	Retaining ring, filter	1001-5954-000
<b>2</b>	<b>Cylinder inlets (DIN)</b>	-----
2a	Screw, M8x16	0144-2140-242
2b	Sealing ring (DIN)	1001-3812-000
2c	DIN Adapter (O <sub>2</sub> )	1006-4000-000
	DIN Adapter (N <sub>2</sub> O)	1006-4001-000
	DIN Adapter (Air)	1006-4002-000
2d	O-ring, 0.687 ID, 0.812 OD	0210-0544-300
2e	Filter, sintered bronze	9914-6380-000
2f	Sealing ring, N <sub>2</sub> O DIN Conn 11	1202-3641-000
2g	Adapter, large cylinder N <sub>2</sub> O	1006-4028-000
2h	Adapter, large cylinder O <sub>2</sub>	1006-4027-000

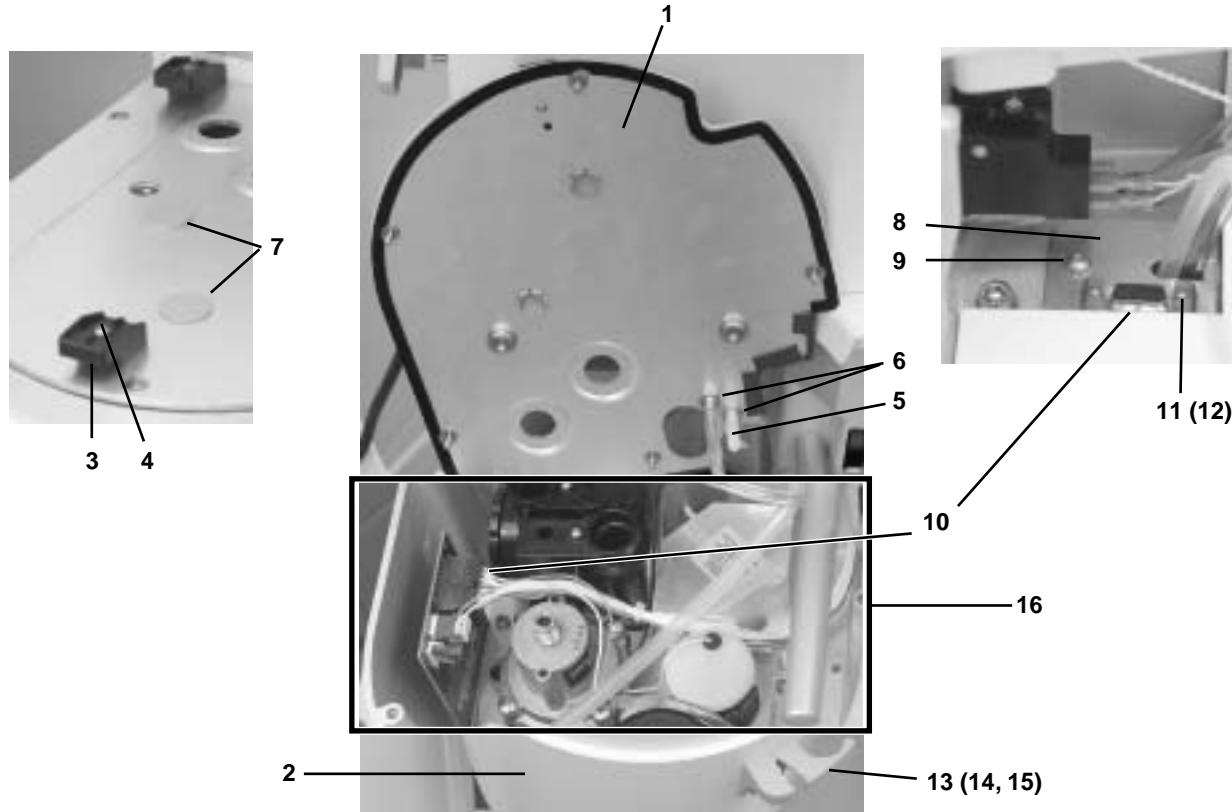
\* Lubricate sparingly with Krytox

## 10.13 Vaporizer manifold



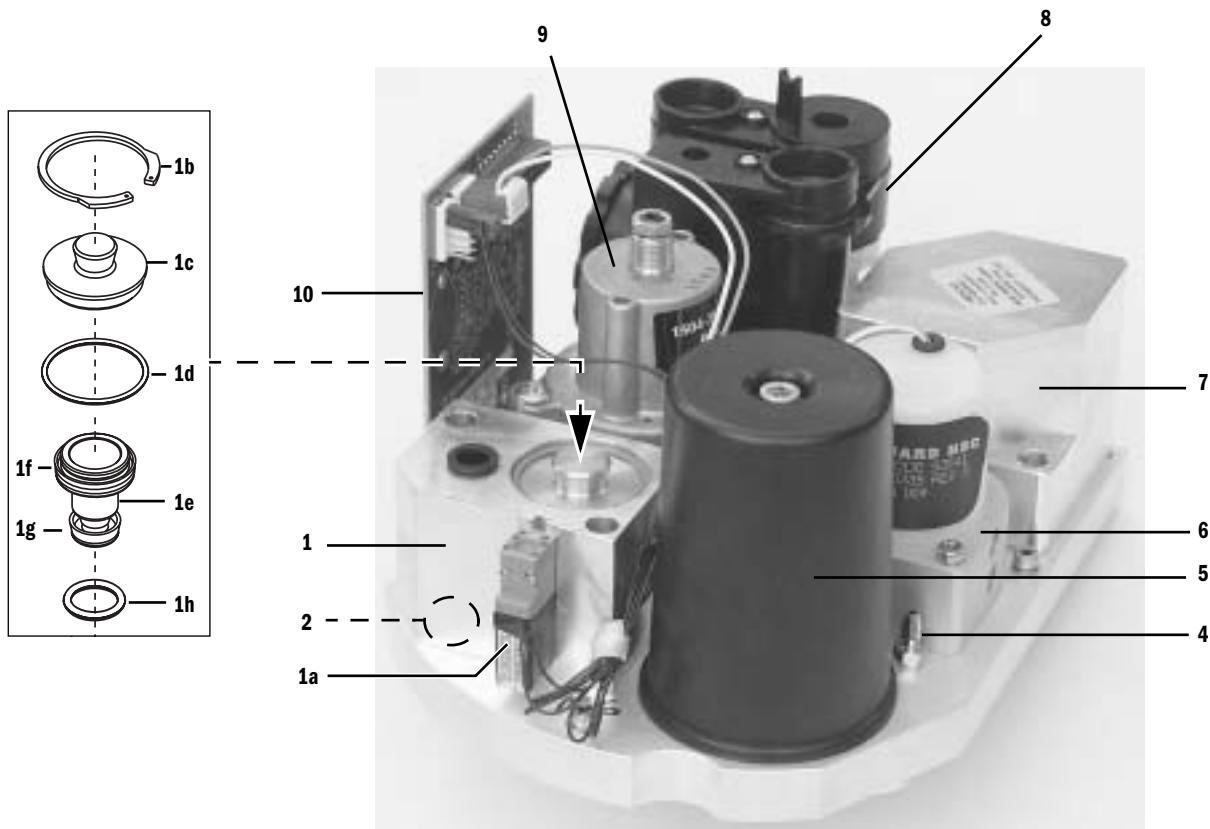
Item	Description	Stock Number
	Manifold assembly, complete, two position	1006-8355-000
	Manifold assembly, complete, one position	1009-8065-000
1	O-ring, 0.687 inch ID 0.812 inch OD	0210-0544-300
2	Spring, compression	1006-3736-000
3	Valve kit, includes seal	1006-8373-000
4	Seal	1006-3690-000
5	O-ring, 14.3 mm ID (Package of 6 o-rings)	1102-3043-000 1102-3016-000
6	Nipple, vaporizer port (New Style)	1006-4215-000
7	Screw, M2.5 - 0.45x6 PAN, Pozidriv, SST	1006-3037-000
8	Spring, Dzus	1102-3056-000
9	Seat, check valve	1006-1352-000
10	O-ring 27.1 OD 21.89 mm ID	1006-3866-000
11	Flapper	0211-1451-100
12	Housing	1006-1351-000
13	Screw, M4 x 30, cap head	9211-0640-304
14	Valve, relief, 5.5 psi, 7/16-20 THD	1006-4128-000
15	Flexible tubing, 1/4 inch, mixed gas	1001-3064-000

## 10.14 Vent Engine Housing



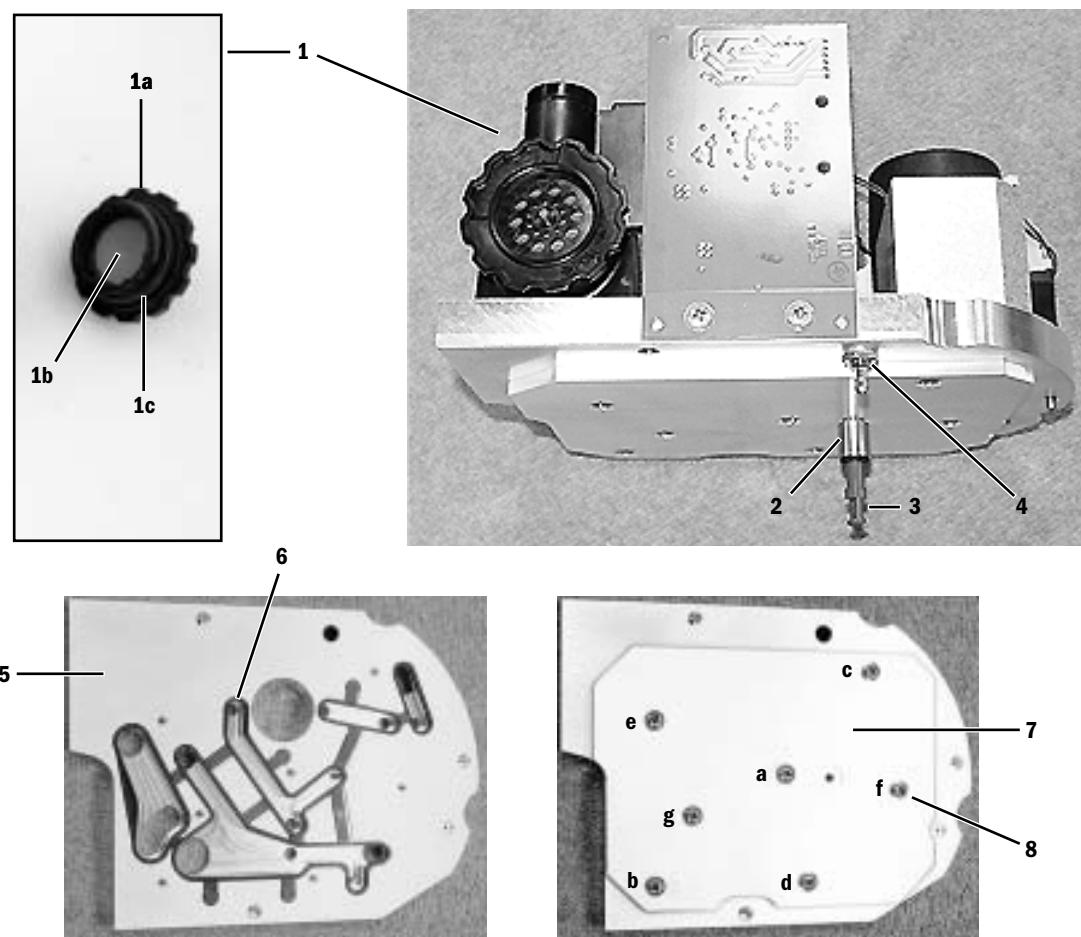
Item	Description	Stock Number	Qty
1	Vent Engine Cover Plate Assy	1407-7009-000	
2	CASTING VENT ENG HOUSING	1407-3301-000	
3	TAB GUIDE BELLOWS BASE	1407-3313-000	(2)
4	SCR M3X16 POSI DR PAN HD A4 SST	1504-3003-000	(2)
5	Cap, Plug	1406-3524-000	
6	FITTING PNL MOUNT 3.18 HOSE BARB UNION	1504-3014-000	(2)
7	PLUG HOLE 15.9 DIA NYLON MICRO PLASTICS	1006-1473-000	
8	PLATE CONN VENT	1407-3321-000	
9	SCR M4X8 POZI-DR DIN84 PAN SERRATED	1006-3178-000	(3)
10	Harness, Vent Engine Board to Connector Plate	1009-5545-000	
11	BLOCK LATCHING DSUB CONN	1504-3617-000	(2)
12	SCR 4-40 X 3/8 SKT BCG HD CAP	0144-2117-206	(2)
13	CLIP-SUCTION BAG HOSE	1407-3327-000	
14	SCR M5 X 16 PAN PH HD SST	9211-8350-163	(2)
15	Lockwasher	0144-1118-220	(2)
16	Vent Engine	Refer to section 10.15	

## 10.15 Vent Engine



Item	Description	Stock Number
	Vent Engine Assembly, Service (Avance)	1009-8216-000
1	Gas Inlet Valve (GIV) components	Refer to section 9.8.3
1a	Solenoid, 3-way NO (with mounting screw)	1503-3853-000
1b	Retaining ring, 34.9 mm	1500-3158-000
1c	Cap, inlet valve	1503-5006-000
1d	O-ring, upper Viton	9221-3032-116
1e	Shuttle, inlet valve	1503-5018-000
1f	U-cup, upper EDPM (fits on shuttle valve)	1503-3090-000
1g	U-cup, lower Viton (fits on shuttle valve)	1503-3089-000
1h	O-ring, lower Viton	1503-3108-000
2	Filter (under GIV), 2-micron (install coarse side DOWN)	1504-3708-000
4	Fitting, manifold pressure	1500-3116-000
5	Reservoir, pneumatic engine O-ring, base, 56.87 ID x 60.43 OD O-ring, screw head, 0.219 ID x 0.344 OD Screw, M6x90	1504-3704-000 1504-3614-000 0210-0686-300 1504-3004-000
6	Flow control valve (HSC) BCG O-ring under flow control valve (2 each)	1503-3854-000 1503-3056-000
7	Drive gas check valve O-ring under drive gas check	1503-3006-000 1503-3213-000
8	Interface Manifold	Refer to section 10.15.1
9	Regulator, 172 kPa BCG	1504-3623-000
10	Vent Engine Connector board (not part of assembly)	1011-3165-000

### 10.15.1 Vent Engine - under side



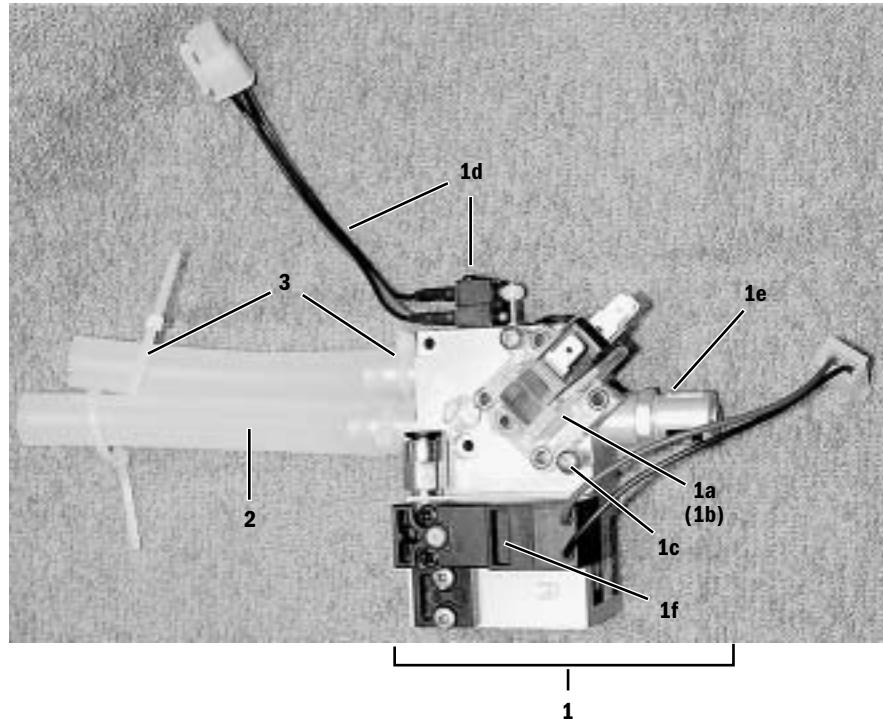
Item	Description	Stock Number
1	Interface Manifold, pneumatic engine (with free breathing valve and mechanical overpressure valve) O-ring, 12.42 ID x 15.98 OD (2)	1504-8505-000 1006-3615-000
1a	Seat, free breathing valve	1503-3204-000
1b*	Valve, flapper	0211-1454-100
1c	O-ring	1503-3208-000
2	Fitting, 6.35-mm (1/4-inch)	1504-3621-000
3	Plug, 6.35-mm (1/4-inch)	1503-3245-000
4	Fitting, barbed	1504-3014-000
5	Manifold	1503-3843-000
6**	Gasket, manifold	1503-3845-000
7	Plate, manifold	1503-3844-000
8***	Screw, M4x8 Pozidriv PAN	1006-3178-000

\* If necessary, clean with alcohol before installing new; trim off flush with outside surface of seat (refer to removed flapper).

\*\* Install gasket into manifold. Check to see that it is properly positioned.

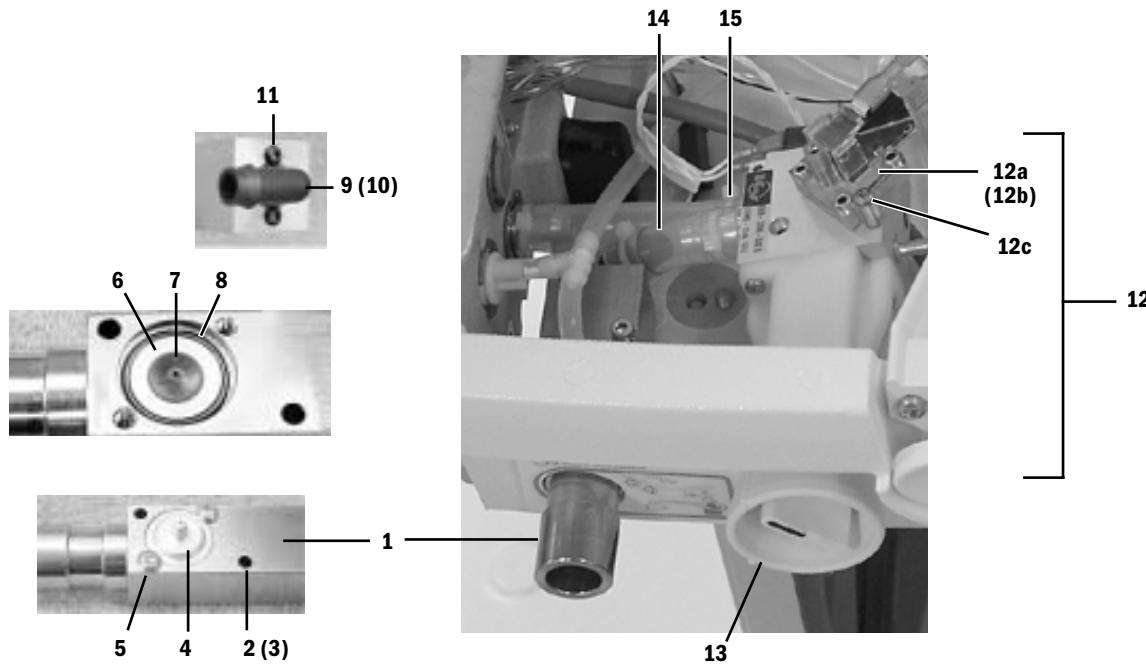
\*\*\* Carefully install plate onto manifold making sure not to disturb the gasket. First, start all screws. Then, torque to 1.7 N·m (15 lb-in) using sequence shown.

## 10.16 ABS to machine Interface Components (SCGO)



Item	Description	Stock Number
1	SCGO Selector Module, complete	1009-3098-000
1a	Flush pressure switch (includes o-ring)	1006-3972-000
1b	O-ring	1006-3213-000
1c	Screws	0144-2124-201
1d	Switch, mode (CGO/SCGO), kit	1009-3282-000
1e	Valve, relief 150 cmH <sub>2</sub> O	1009-3052-000
1f	Solenoid kit CGO	1009-3279-000
2	Tubing, silicone (110 mm, 100 mm)	1009-3164-000
3	Tie wrap	0203-5915-300

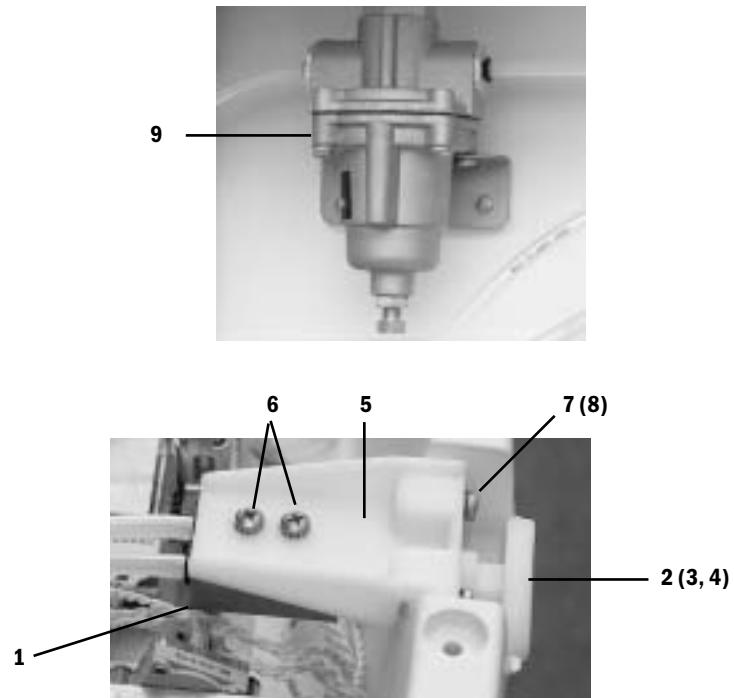
## 10.17 ABS to machine Interface Components (ACGO)



Item	Description	Stock Number
1	Port, ACGO body	1009-3096-000
2	Screw, M4x30	9211-0640-304
3	Lockwasher, M4	9213-0540-003
4	Cap, ACGO check valve	1009-3095-000
5	Screw, M4x8	9211-1040-069
6	Disk, ACGO check valve	1009-3062-000
7	Flapper, ACGO check valve	1009-3097-000
8*	O-ring	0210-0543-300
9	Fitting, elbow barbed	1009-3160-000
10*	O-ring	0210-0691-300
11	Screw, M3x6	9211-1030-055
12	ACGO Selector Switch, complete (without guard - item 13)	1009-3099-000
12a	Flush pressure switch	1006-3972-000
12b	O-ring	1006-3213-000
12c	Screws	0144-2124-201
13	Guard	1009-3140-000
14	Tubing, silicone	1009-3164-000
15	Tie wrap	0203-5915-300

\* Lubricate sparingly with Krytox.

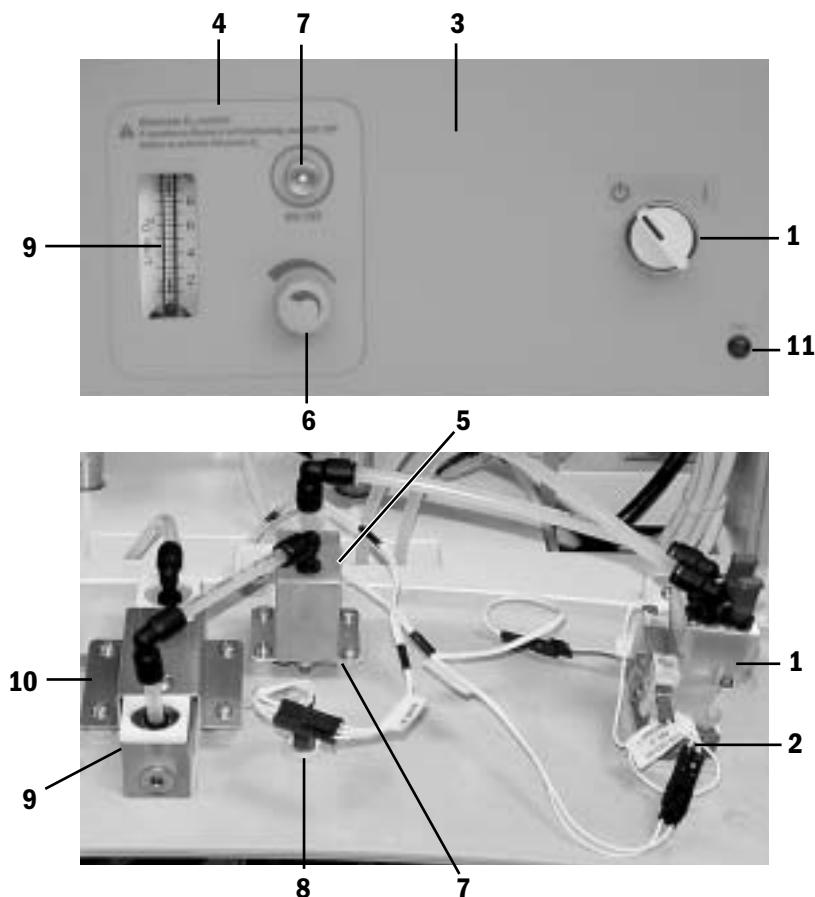
## 10.18 Flush Regulator and Flush Valve



Item	Description	Stock Number
1	Flush valve, without button	1006-8357-000
2	Flush Button with rod	1011-3354-000
3	Spring	1006-3186-000
4	E-clip	0203-5225-300
5	Bracket	1011-3355-000
6	Screw, M4x8	1006-3178-000
7	Screw, M4x12	0140-6226-111
8	Lockwasher, M4	9213-0540-003
9	Regulator, O <sub>2</sub> Flush	1011-3168-000

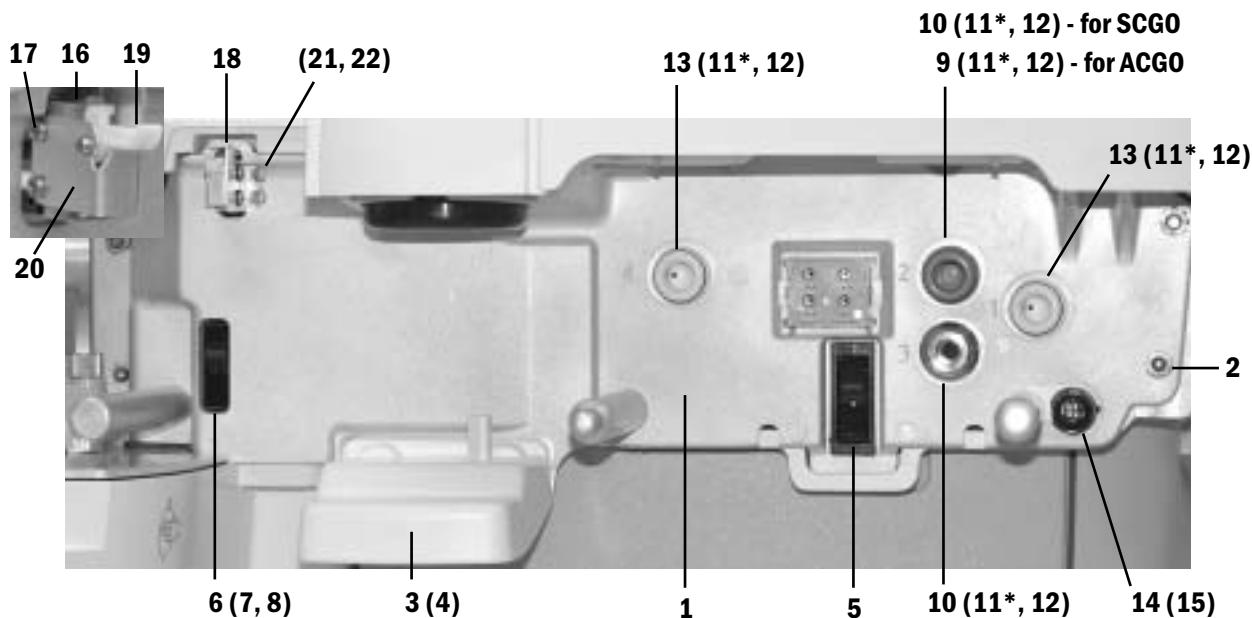
## 10.19 Front panel, Alt O<sub>2</sub>, and system switch

<b>Table 1:</b>	
<b>Language</b>	<b>Alt O<sub>2</sub> Label</b>
Chinese	1009-3332-000
Czech	1009-3322-000
Danish	1009-3331-000
Dutch	1009-3317-000
English	1009-3315-000
Finnish	1009-3321-000
French	1009-3316-000
German	1009-3314-000
Greek	1009-3326-000
Hungarian	1009-3327-000
Italian	1009-3318-000
Japanese	1009-3328-000
Norwegian	1009-3324-000
Polish	1009-3323-000
Portuguese	1009-3320-000
Russian	1009-3330-000
Spanish	1009-3319-000
Turkish	1009-3325-000



<b>Item</b>	<b>Description</b>	<b>Stock Number</b>
1	Switch, D-O system	1006-8452-000
2	Harness, On/Standby system switch	1009-5542-000
3	Panel	1009-3019-000
4	Label, Alt O <sub>2</sub>	See Table 1
5	Needle Valve assembly, flow control	1011-3429-000
6	Knob (set screw not included)	1011-3472-000
	Set screw	9211-0830-053
7	Bracket	1009-3127-000
	Screw, M4x8 (bracket to needle valve - 2 each)	0144-2436-108
	Screw, M4x10 (assembly to front panel - 4 each)	1009-5534-000
8	Switch, Alt O <sub>2</sub> (includes harness)	1009-5517-000
9	Flowmeter, Alt O <sub>2</sub>	1011-3428-000
10	Bracket, flowmeter	1009-3126-000
	Screw, 10-32x3/8 (bracket to flowmeter - 2 each)	0140-6631-107
	Screw, M4x10 (assembly to front panel - 4 each)	1009-5534-000
11	LED assembly, mains green	1009-5514-000

## 10.20 Breathing system interface

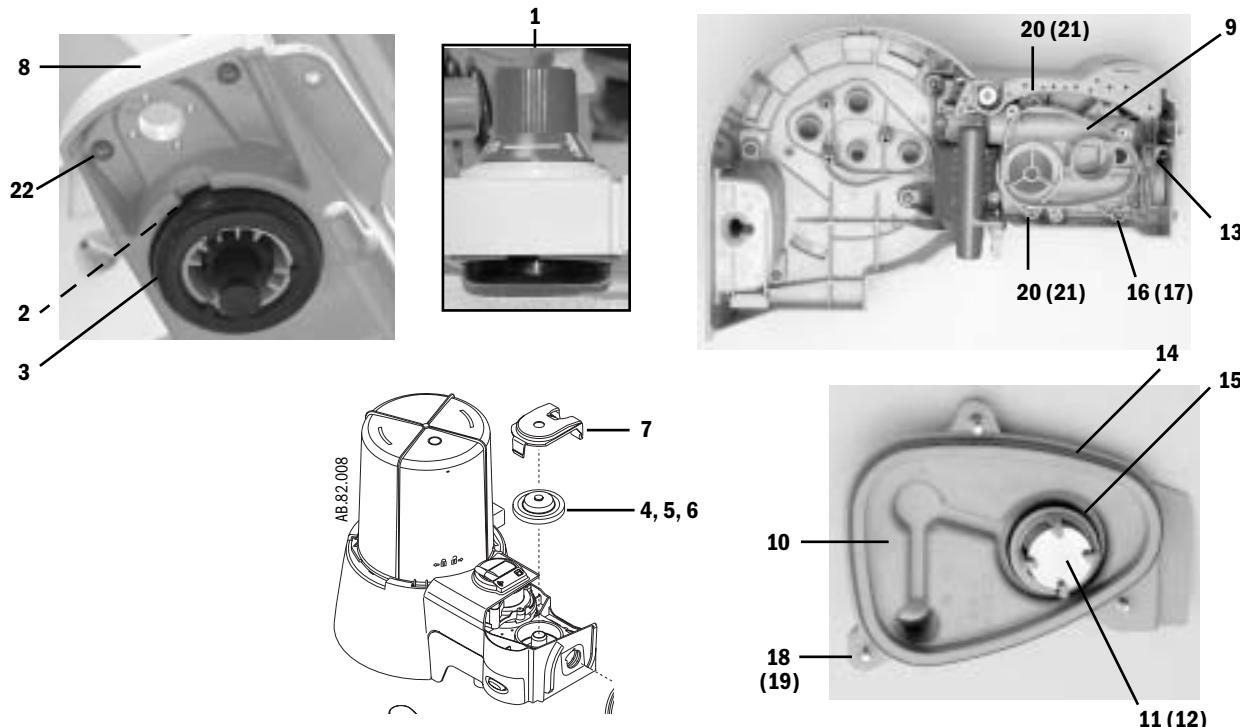


Item	Description	Stock Number	Qty
1	ASSEMBLY MAIN SUPPORT CASTING	1407-7010-000	
2	Bolt, M6x16 flange	1009-3125-000	(5)
3	HANDLE GRIP	1407-3317-000	
4	SCR M6X16 Sems	0144-2436-109	(2)
5	LATCH PUSH TO CLOSE	1407-3309-000	
6	LATCH PUSH TO CLOSE W/MICROSWITCH	1407-3310-000	
7	SCR SKT HD CAP M3-0.5X8 SST	1006-3865-000	(2)
8	WASHER LOCK EXTERNAL M3	9213-0530-003	(2)
9	Port, plug circuit	1407-3333-000	
10	Port, fresh gas	1407-3314-000	
11*	SEAL U-CUP 12.7 ID BCG 19.05 OD EPR	1407-3320-000	(4)
12	RING RET 15.88 SHAFT DIA TYPE E SST	1406-3446-000	(4)
13	Port, sample gas	1407-3318-000	(2)
14	Connector, BULKHEAD O2 CELL, with harness	1009-5586-000	
15	RING RETAINING 9.53 SFT DIAMETER TYPE E SST	1406-3277-000	
16	SW SUBMINITURE W/QDISC TERMINALS	1406-3296-000	
17	SCR M2.5 X 10	1009-3153-000	(2)
18	BRACKET BTV SWITCH	1407-3319-000	
19	LEVER BTV SWITCH	1407-3325-000	
20	CAP BRACKET BTV	1407-3324-000	
21	SCR SKT HD CAP M3-0.5X8 SST	1006-3865-000	(2)
22	WASHER LOCK EXTERNAL M3	9213-0530-003	(2)

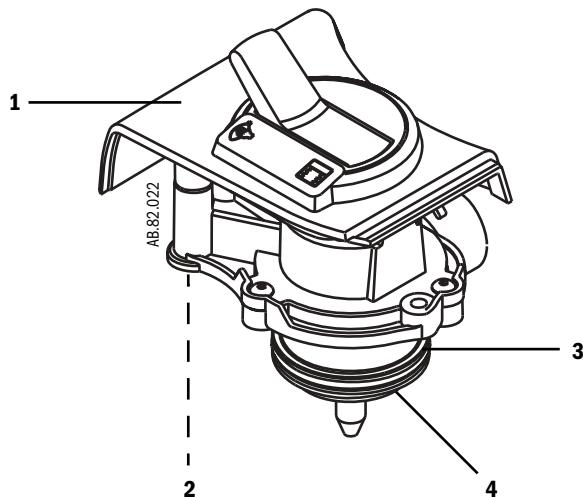
\* Lubricate sparingly with Krytox.

## 10.21 Breathing System

### 10.21.1 APL Valve

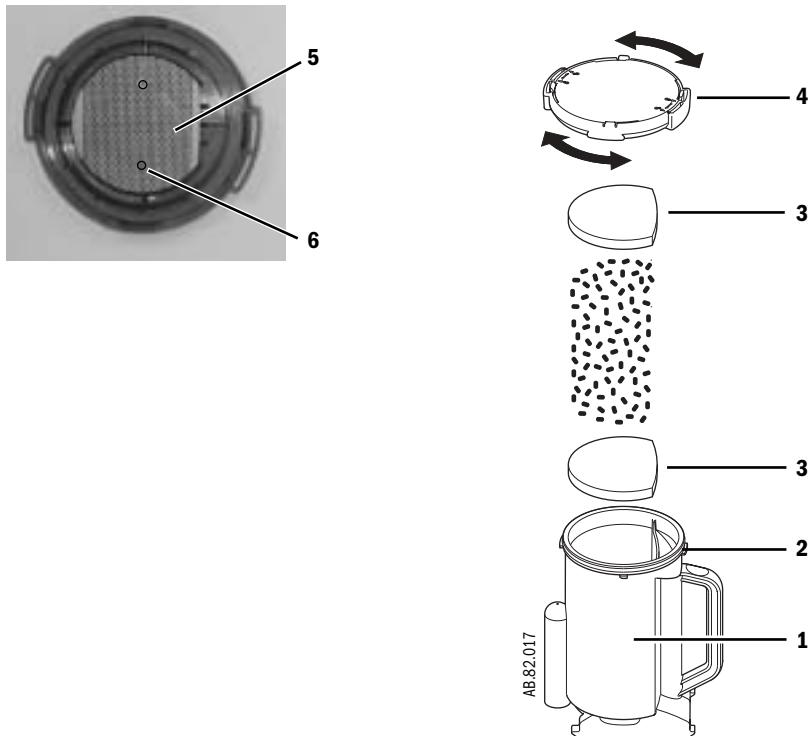


Item	Description	Stock Number	QTY
1	APL Valve Assy (includes items 2 through 6)	1009-8200-000	
2	SPRING CPRSN 53.14 OD 36.8 L 1.48 N/MM	1406-3328-000	
3	RETAINER SPRING APL	1407-3404-000	
4	DIAPHRAGM APL	1406-3331-000	
5	CAGE APL	1406-3333-000	
6	POPPET APL VALVE	1406-3332-000	
7	RAMP APL	1407-3400-000	
8	COVER APL	1407-3405-000	
9	MANIFOLD APL/BTV	1407-3401-000	
10	Cover, Manifold APL/BTV (with 22-mm male bag port)	1407-3402-000	
	Cover, Manifold APL/BTV (with Australian bag port - 22 mm female)	1407-3412-000	
11	WEIGHT DEAD 14CM H2O BCG ABS NEG RELIEF	1407-3406-000	
12	SEAL ABS NEG RELIEF VLV	1407-3407-000	
13	O-RING 22 ID 30 OD 4 W SI 40 DURO	1407-3104-000	
14	O-RING 88.49 ID 95.55 OD 3.53 W SILICONE 50 DURO	1407-3403-000	
15	O-RING 1.049 ID 1.2550D .103W EPDM NO 121	1407-3408-000	
16	SCR M4X16 BT SKT HD SST TYPE 316	0140-6226-115	(2)
17	Lockwasher, M4 external	9213-0540-003	(2)
18	SCR THUMB M4 SHLD 7.5 X 7	1407-3410-000	(3)
19	RING RETAINING 3.96 SFT DIA CRESCENT SST	1407-3411-000	(3)
20	SCR M4 X 40 FL HD SST PH	0140-6226-122	(2)
21	O-RING 2.9 ID 6.46 OD 1.78 W EP 70 DURO	1407-3409-000	(2)
22	SCR SEMS M4X8 BT SKT HD W/EXT L/W SST 316	0144-2436-108	(3)

**10.21.2 Bag/Vent Switch**

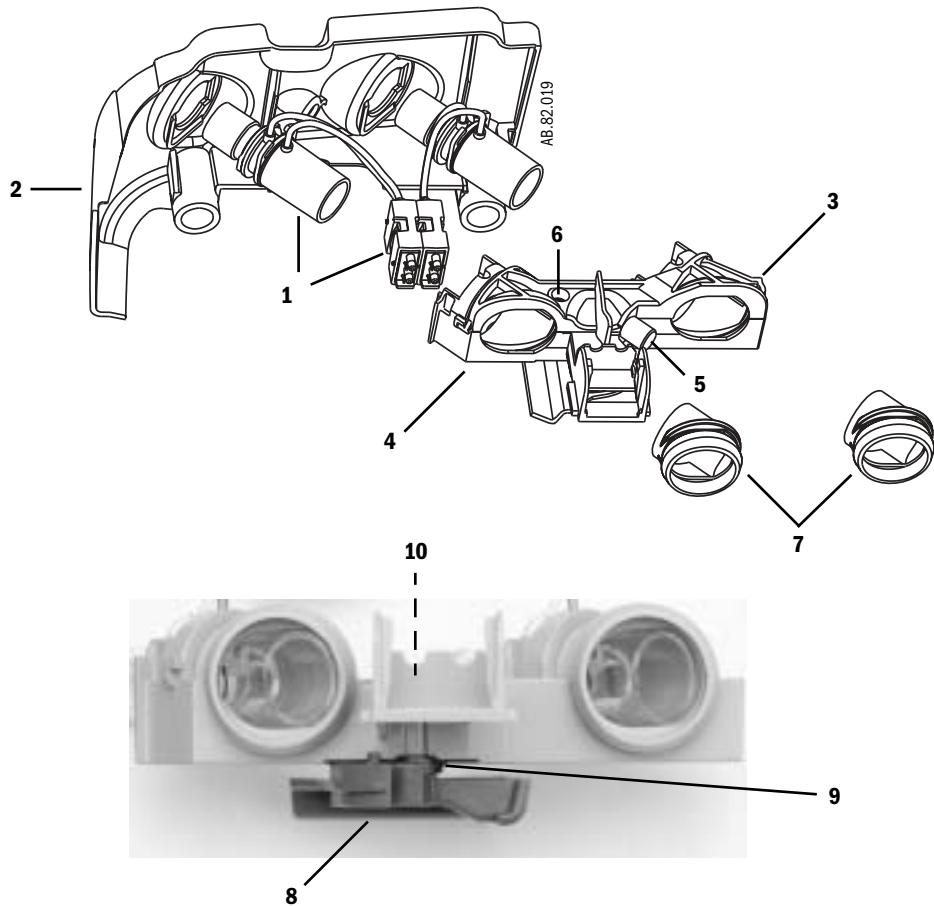
Item	Description	Stock Number	QTY
	BTV Switch Cartridge	1407-7003-000	
1	COVER BTV	1407-3500-000	
2	SCR SEMS M4X8 BT SKT HD W/EXT L/W SST 316	0144-2436-108	(2)
3	O-RING 44.02 ID 51.1 OD 3.53 W SI 70 DURO	1407-3507-000	
4	SEAL, BTV	1407-3506-000	

### 10.21.3 Absorber canister



Item	Description	Stock Number	Qty
	Absorber Canister, Reusable	1407-7004-000	
1	CANISTER, CO2	1407-3200-000	
2	O-RING 110.72 ID 117.78 OD 3.53 W EPR 50 DURO	1407-3204-000	
3	FOAM, CO2 CANISTER (PKG 40)	1407-3201-000	
4	COVER, CO2 CANISTER with LOCKING RING (does not include items 5 and 6)	1407-3203-000	
5	SCREEN, CO2 CANISTER COVER	1407-3205-000	
6	SCREW, M3X8 FL PH HD SST	9211-0530-083	(2)

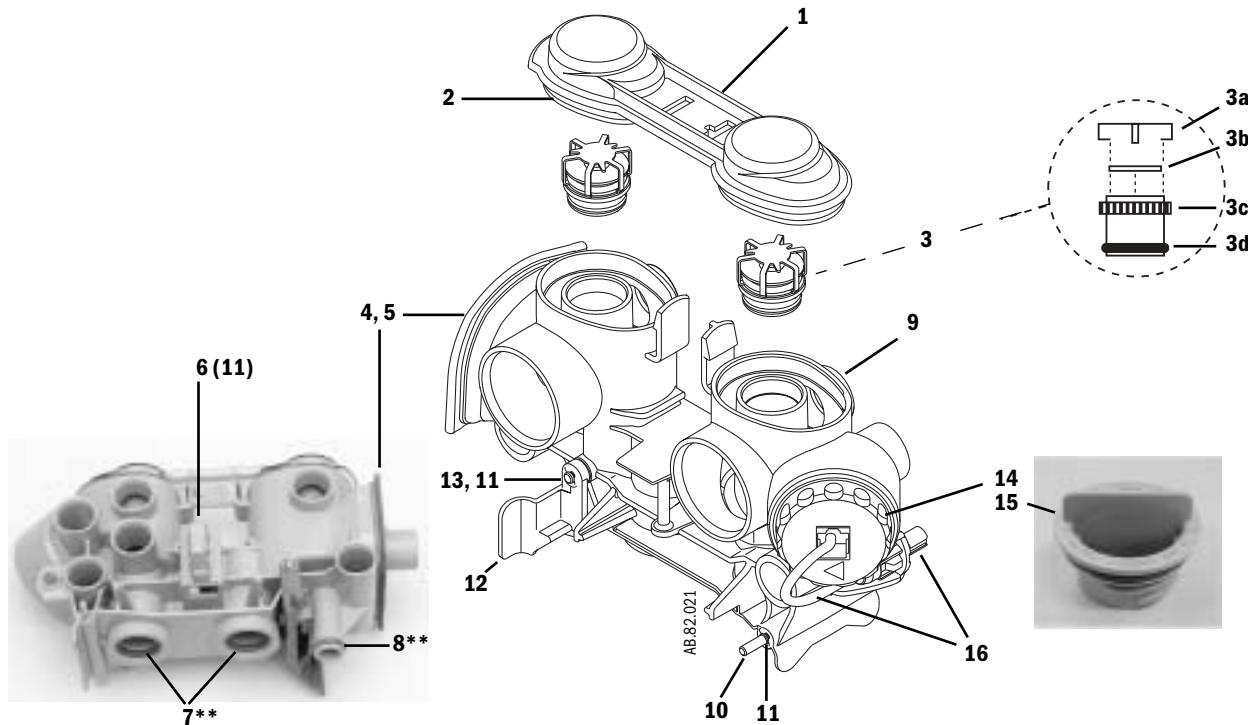
### 10.21.4 Flow Sensor Module



Item	Description	Stock Number	Qty
	Flow Sensor Module (*)	1407-7001-000	
1*	Flow Sensor (plastic)	1503-3856-000	
	Flow Sensor (metal - autoclavable)	1503-3224-000	
	Flow Port Adapter	1503-3849-000	
2	COVER FLOW SNSR	1407-3000-000	
3	HOLDER FLOW SNSR UPPER	1407-3002-000	
4	HOLDER FLOW SNSR LOWER	1407-3003-000	
5	SCR THUMB M6X43 SST	1406-3304-000	
6	SCR M4 .07 X 10 SKT CAP BUTTON HEAD SST	0144-2117-718	(2)
7	CUFF FLOW SNSR	1407-3004-000	(2)
8	LATCH FLOW SNSR	1407-3001-000	
9	SPR TORSION FLOW SNSR LATCH	1407-3005-000	
10	RING TRUARC .188 SHAFT E-RING SST	0203-5225-300	

\* The flow sensors are not included in the flow sensor module.

### 10.21.5 Breathing Circuit Module

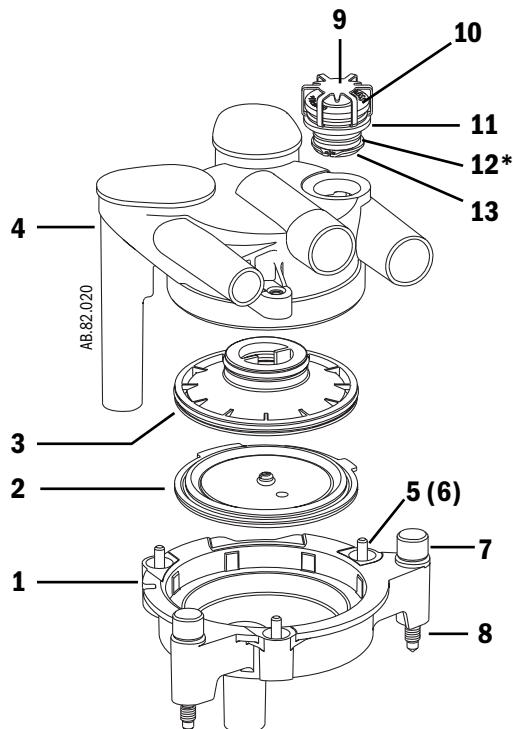


Item	Description	Stock Number	Qty
	Breathing Circuit Module	1407-7002-000	
1	LENS CIRCUIT CHK VALVES	1407-3101-000	
2	O-RING 44.02 ID 51.1 OD 3.53 W SI 70 DURO	1407-3507-000	(2)
3	Check Valve Assembly	1406-8219-000	(2)
3a	RETAINER DISK 26.97D 12.7H 0.76T	1400-3017-000	(2)
3b	DISC CHK V RVSBL 1.025D	0210-5297-100	(2)
3c	SEAT UNIDIRECTIONAL V B/S	1406-3396-000	(2)
3d	O-RING 20.35 ID 23.90 OD 1.78W	1406-3397-000	(2)
4	PLATE CIRCUIT FLANGE	1407-3110-000	
5	SCR SEMS M4X8 BT SKT HD W/EXT L/W SST 316	0144-2436-108	(6)
6	HOOK LATCH	1407-3604-000	
7**	O-RING 22 ID 30 OD 4 W SI 40 DURO	1407-3104-000	(2)
8**	O-RING 13.94 ID 19.18 OD 2.62 W SI 50 DURO	0210-0463-300	
9	MANIFOLD CIRCUIT	1407-3100-000	
10	PIN CANISTER PIVOT	1407-3109-000	
11	RING TRUARC .188 SHAFT NO 5133-18H E-RING SST	0203-5225-300	(5)
12	LEVER CANISTER LATCH	1407-3102-000	
13	PIN CANISTER LEVER	1407-3108-000	
14*	O <sub>2</sub> Cell	6050-0004-110	
	O-ring, cell	1406-3466-000	
15*	Plug with o-ring (for units without circuit O <sub>2</sub> sensing)	1503-3857-000	
	O-ring, plug	1407-3112-000	
16*	Cable, O <sub>2</sub> Cell	1009-5570-000	

\* The O<sub>2</sub> cell (or plug) and the cell cable are not included in the breathing circuit module.

\*\* Lubricate sparingly with Krytox.

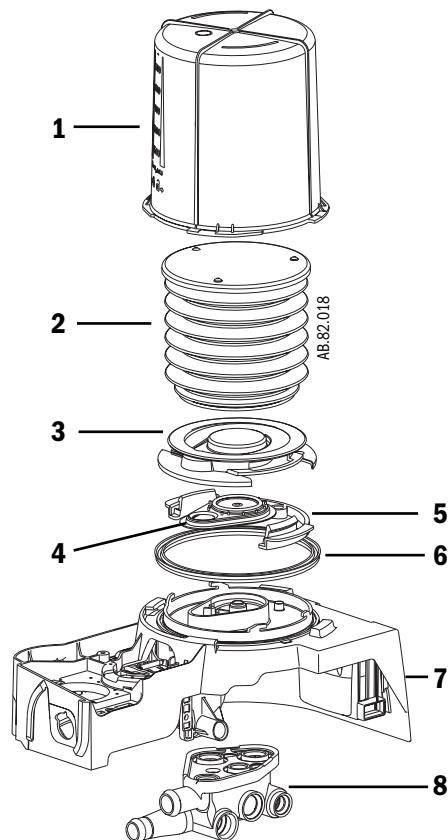
### 10.21.6 Exhalation valve



Item	Description	Stock Number	Qty
	Exhalation Valve Assy	1407-7005-000	
1	BASE EXHALATION VALVE	1407-3700-000	
2	DIAPHRAGM ASSY EXH VALVE	1503-8121-000	
3	SEAT EXHALATION VLV ABS	1407-3704-000	
4	COVER EXHALATION VALVE	1407-3701-000	
5	SCR M4X16 PH PAN HD SST TYPE 316	9211-0440-163	(3)
6	O-RING 2.9 ID 6.46 OD 1.78 W EP 70 DURO	1407-3409-000	(3)
7	SCR THUMB M6X43 10MM HEAD B/S	1406-3306-000	(2)
8	O-RING 4.47 ID X 8.03 OD 1.78 W EPR 70 DURO	1407-3703-000	(2)
9	RETAINER DISK 26.97D 12.7H 0.76T SST FLUTTER V	1400-3017-000	
10	WEIGHT DEAD 10 CMH20 BCG PASSIVE AGSS	1406-3572-000	
11	SEAT POSITIVE PRESS BCG VALVE PASSIVE AGSS	1406-3571-000	
12*	O-RING OD19.16 BCG ID15.6 EPDM DURO 70 -016	1006-3616-000	
13	RING RETAINING 19.05 SHAFT DIA SST	1406-3577-000	

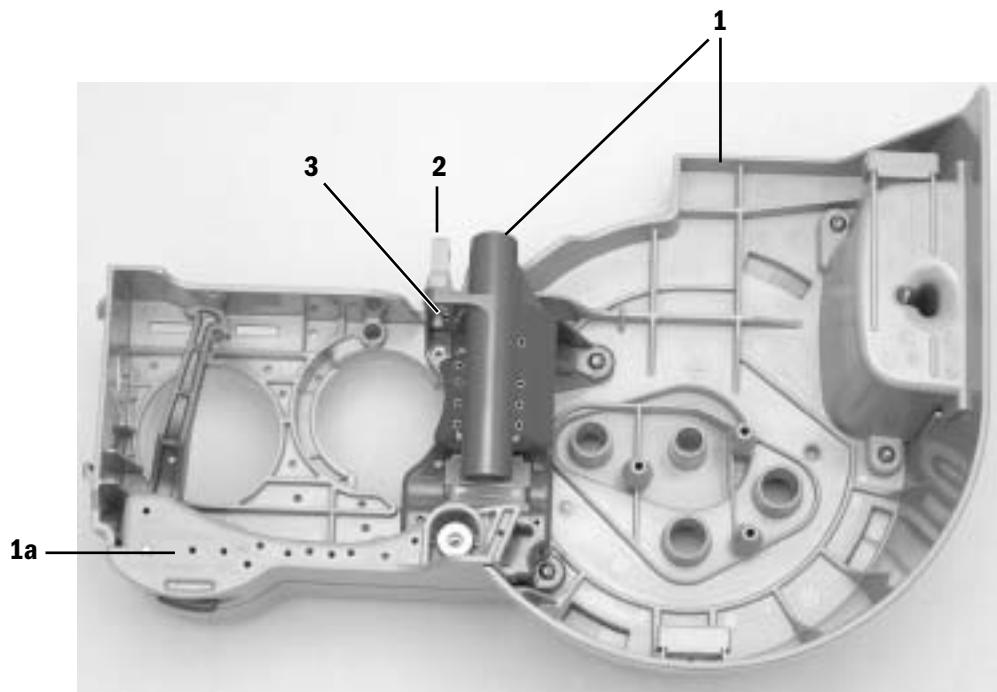
\* Lubricate sparingly with Krytox.

### 10.21.7 Bellows



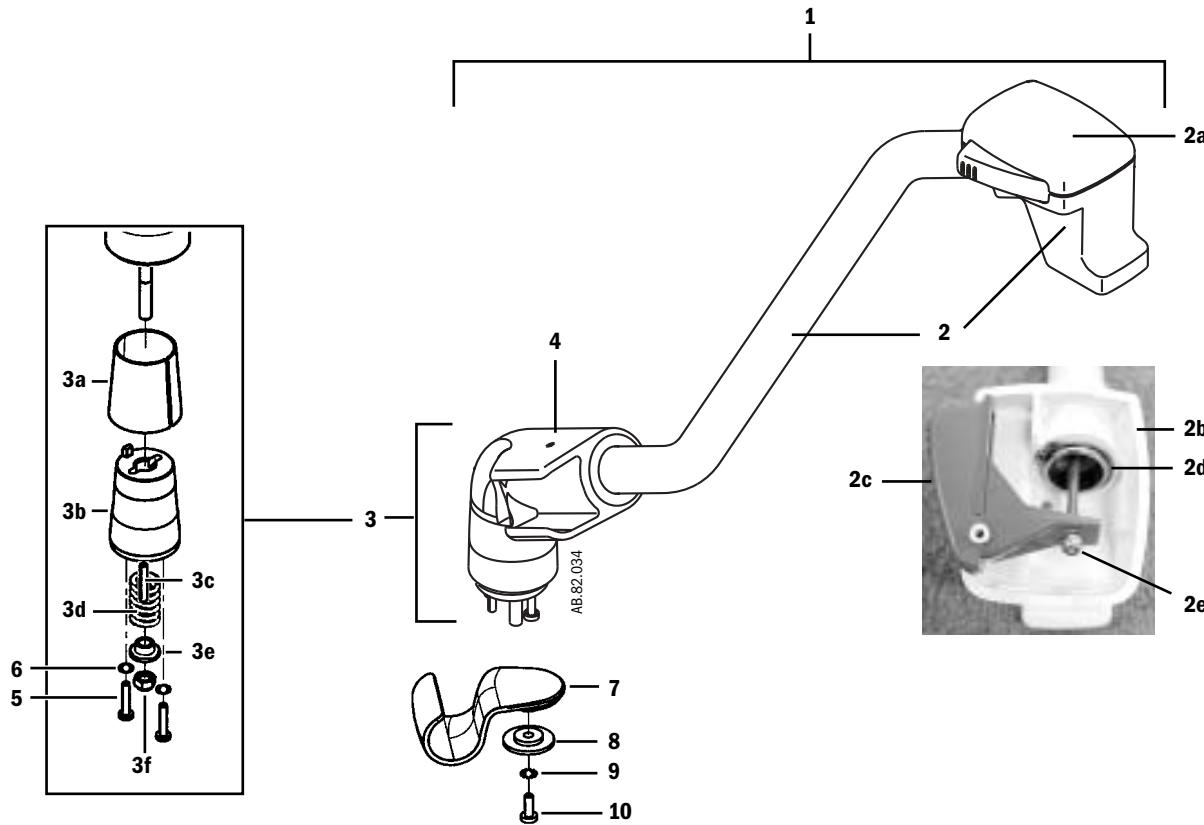
Item	Description	Stock Number
1	Bellows housing	1500-3117-000
2	Bellows	1500-3378-000
3	Rim	1500-3351-000
4	Pressure relief valve assy	1500-3377-000
5	Latch, base	1500-3352-000
6	Seal, base	1500-3359-000
7	Base, bellows	Refer to section 10.21.8
8	Manifold, bellows base	1407-3702-000

### 10.21.8 Bellow base



Item	Description	Stock Number
1	Bellows Base Assy	1407-7006-000
1a	Latch Assy	1407-7007-000
2	HOOK LATCH	1407-3604-000
3	E-Ring	0203-5225-300

### 10.21.9 Bag Arms



Item	Description	Stock Number	Qty
1	Bag Arm Assembly (complete)	1009-8159-000	
2	Bag Arm Upper Assembly	1407-7011-000	
2a	Cover, bag port housing	1407-3807-000	
	Screw, M3x20	0140-6719-103	
	Lockwasher, M3 internal	9213-0430-003	
2b	Housing, bag port	1407-3806-000	
2c	Lever, lock release	1407-3808-000	
2d	Ring, retaining	1406-3577-000	
2e	Nut, M3 Nyloc	0144-3536-112	
3	Bag Arm Lower Assembly	1407-7012-000	
3a	Pad, Friction Material	1407-3818-000	
3b	Post	1407-3802-000	
3c	Pin, spiro	9214-2103-020	
3d	Spring	1406-3270-000	
3e	Washer, shoulder	1407-3815-000	
3f	Nut, M5 Nyloc	9212-0350-006	
4	Pin, dowel 3.18 DIA 31.8 L SST	1407-3804-000	
5	Screw, M3x16 POSI DR PAN HD A4 SST	1504-3003-000	(2)
6	Lockwasher, M3 internal	9213-0430-003	(2)
<b>Items if no Bag Arm</b>			
5	Clip, patient tubing	1407-3810-000	
6	Washer, shoulder	1407-3814-000	
7	Lockwasher, M4 external	9213-0540-003	
8	Screw, M4x16	9211-0440-163	

## 10.22 Anesthetic Gas Scavenging System – AGSS

### 10.22.1 Passive AGSS

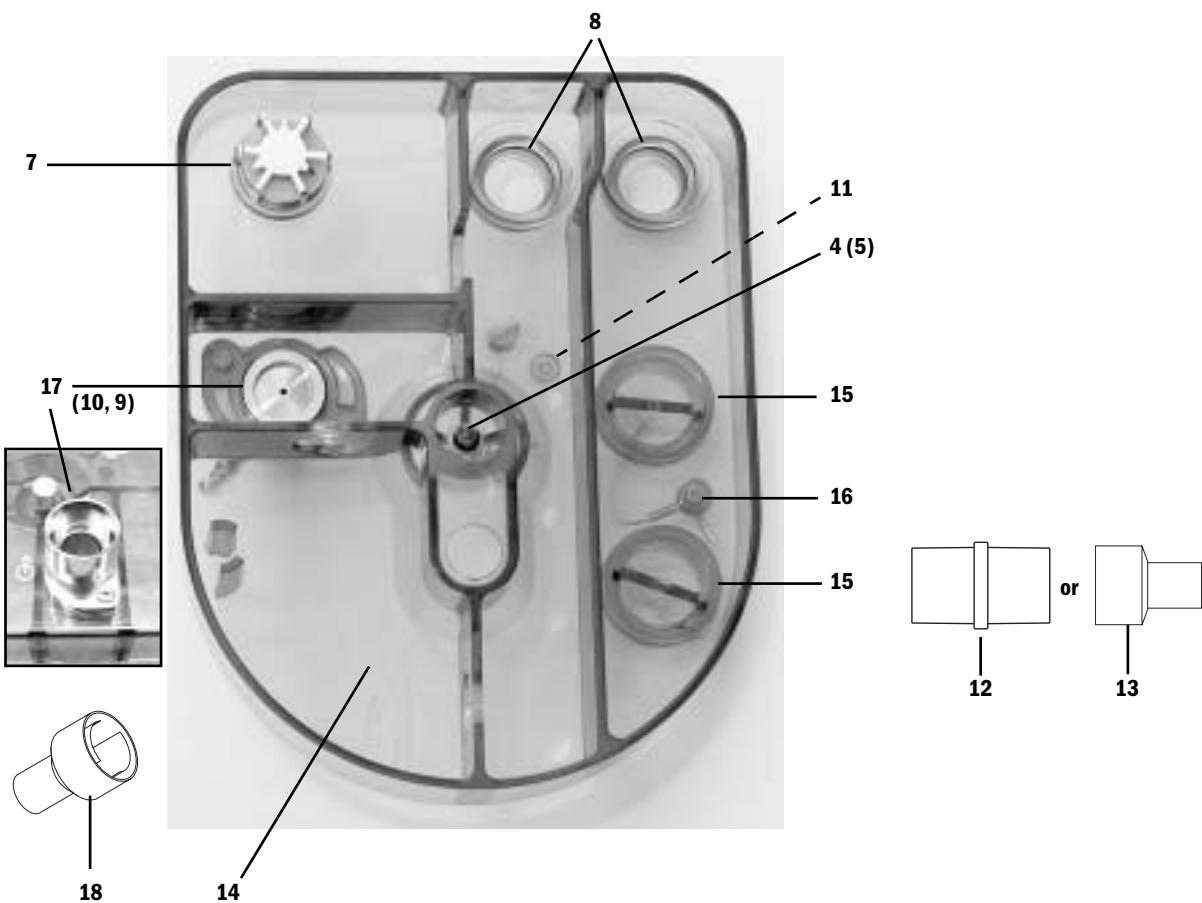
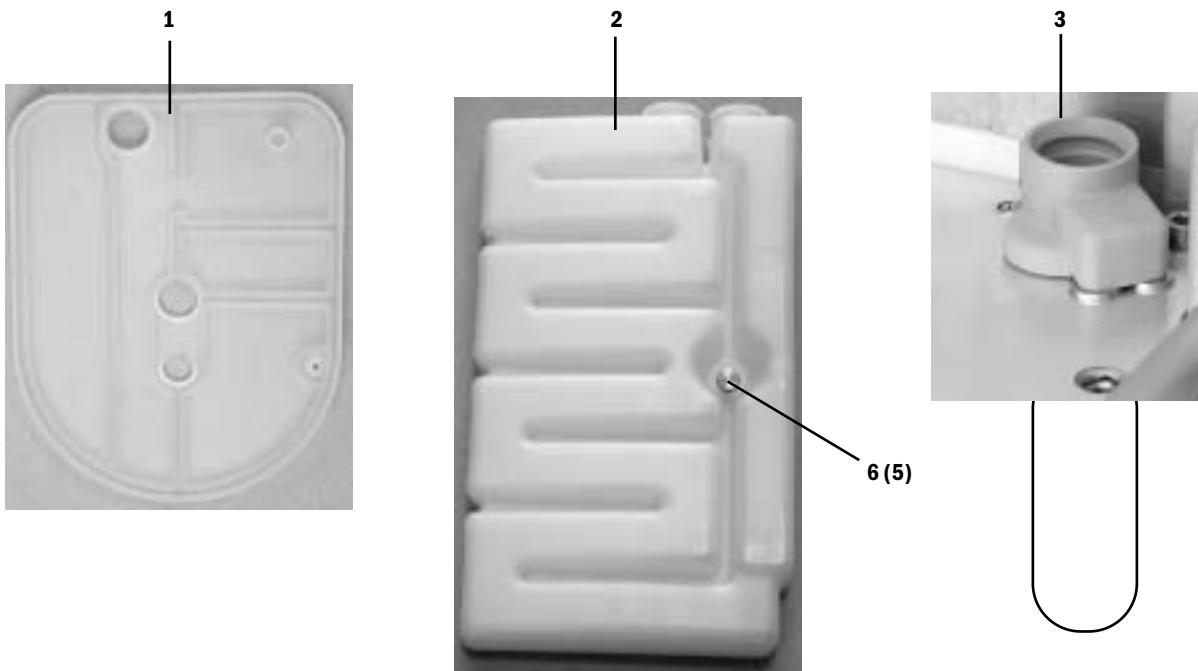
Items 1 through 12 are included in all AGSS kits.

Item	Description, Common Parts	Stock Number	Qty
1	Seal, Receiver Body	1407-3901-000	
2	Reservoir	1407-3903-000	
3	Seal and scavenging down-tube	1407-3904-000	
4	Thumbscrew, M6x28.5	1406-3305-000	
5	O-ring, 4.42 ID, 9.65 OD	1407-3923-000	(2)
6	Thumbscrew, M6x43	1406-3304-000	
7	Valve, unidirectional (negative pressure relief)	1406-8219-000	
7a	Seat, Valve, Negative Pressure	1406-3396-000	
7b	Retainer, disc	1400-3017-000	
*7c	O-ring, 20.35 ID, 23.90 OD	1406-3397-000	
7d	Disc, check-valve	0210-5297-100	
8*	O-ring, 22 ID, 30 OD silicone	1407-3104-000	(2)
9*	O-ring, 21.95 ID, 25.51 OD	1406-3558-000	
10	Screw, M4x8	9211-0640-083	(2)
11	Cap, 3.18 Barb, Silicone	1406-3524-000	
12	Adapter, auxiliary inlet, 30-mm male to 30-mm male	M1003134	
13	Adapter, auxiliary inlet, 30-mm male to 19-mm male	M1003947	

#### Passive AGSS Specific Parts

14	Receiver, Passive/Adjustable	1407-3908-000	
15	Plug Assembly, tethered	1407-3909-000	(2)
16	Screw, shoulder M3	1407-3915-000	
17	Connector, 30-mm ISO, Male	1406-3555-000	
18	Adapter, scavenging, 30-mm female to 19-mm male	1500-3376-000	(5 pack)

\* Lubricate sparingly with Krytox



## 10.22.2 Adjustable AGSS

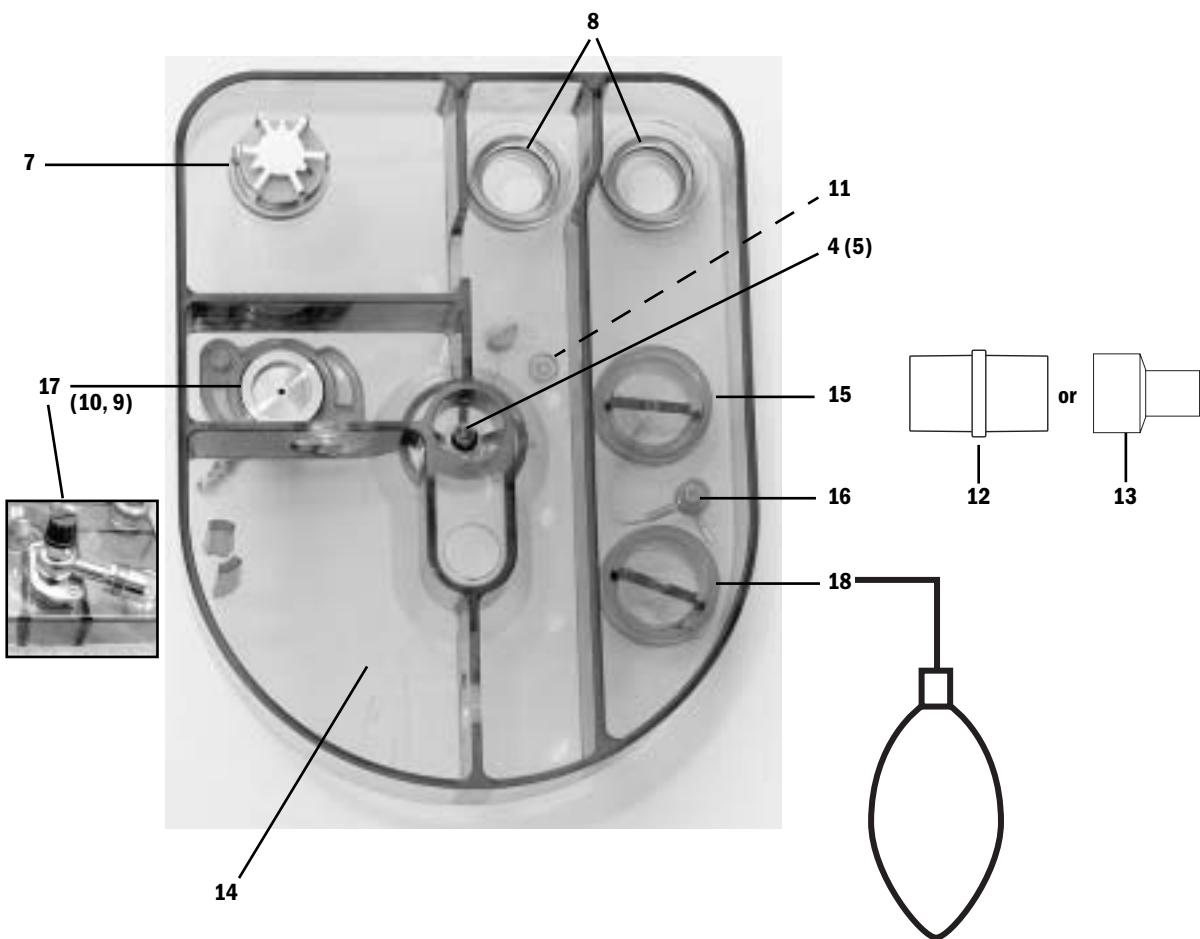
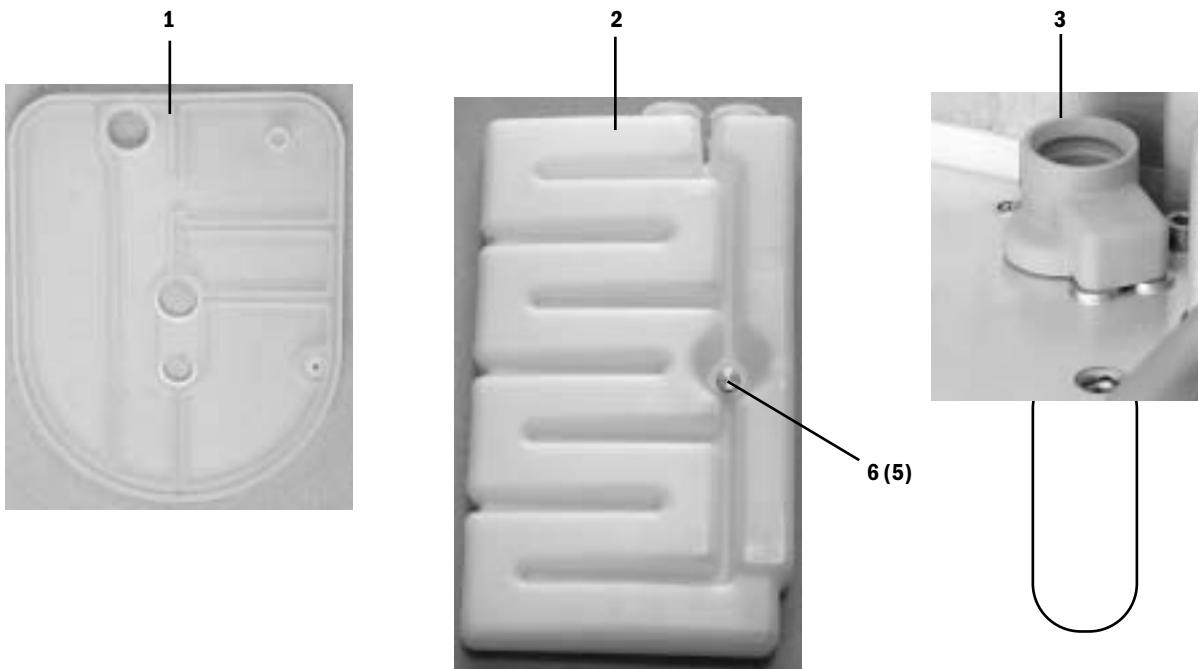
Items 1 through 12 are included in all AGSS kits.

Item	Description, Common Parts	Stock Number	Qty
1	Seal, Receiver Body	1407-3901-000	
2	Reservoir	1407-3903-000	
3	Seal and scavenging down-tube	1407-3904-000	
4	Thumbscrew, M6x28.5	1406-3305-000	
5	O-ring, 4.42 ID, 9.65 OD	1407-3923-000	(2)
6	Thumbscrew, M6x43	1406-3304-000	
7	Valve, unidirectional (negative pressure relief)	1406-8219-000	
7a	Seat, Valve, Negative Pressure	1406-3396-000	
7b	Retainer, disc	1400-3017-000	
*7c	O-ring, 20.35 ID, 23.90 OD	1406-3397-000	
7d	Disc, check-valve	0210-5297-100	
8*	O-ring, 22 ID, 30 OD silicone	1407-3104-000	(2)
9*	O-ring, 21.95 ID, 25.51 OD	1406-3558-000	
10	Screw, M4x8	9211-0640-083	(2)
11	Cap, 3.18 Barb, Silicone	1406-3524-000	
12	Adapter, auxiliary inlet, 30-mm male to 30-mm male	M1003134	
13	Adapter, auxiliary inlet, 30-mm male to 19-mm male	M1003947	

### Adjustable AGSS Specific Parts

14	Receiver, Passive/Adjustable	1407-3908-000
15	Plug Assembly, tethered	1407-3909-000
16	Screw, shoulder M3	1407-3915-000
17	Needle Valve Assembly (with DISS EVAC connector)	1407-3918-000
18	Bag with 30 mm male connector	8004460

\* Lubricate sparingly with Krytox



### 10.22.3 Active AGSS

Items 1 through 12 are included in all AGSS kits.

Item	Description, Common Parts	Stock Number	Qty
1	Seal, Receiver Body	1407-3901-000	
2	Reservoir	1407-3903-000	
3	Seal and scavenging down-tube	1407-3904-000	
4	Thumbscrew, M6x28.5	1406-3305-000	
5	O-ring, 4.42 ID, 9.65 OD	1407-3923-000	(2)
6	Thumbscrew, M6x43	1406-3304-000	
7	Valve, unidirectional (negative pressure relief)	1406-8219-000	
7a	Seat, Valve, Negative Pressure	1406-3396-000	
7b	Retainer, disc	1400-3017-000	
*7c	O-ring, 20.35 ID, 23.90 OD	1406-3397-000	
7d	Disc, check-valve	0210-5297-100	
8*	O-ring, 22 ID, 30 OD silicone	1407-3104-000	(2)
9*	O-ring, 21.95 ID, 25.51 OD	1406-3558-000	
10	Screw, M4x8	9211-0640-083	(2)
11	Cap, 3.18 Barb, Silicone	1406-3524-000	
12	Adapter, auxiliary inlet, 30-mm male to 30-mm male	M1003134	
13	Adapter, auxiliary inlet, 30-mm male to 19-mm male	M1003947	

#### Active AGSS Specific Parts

14	Receiver, with air brake	1407-3900-000
15	Seal, for filter and orifice	1407-3902-000
16	Filter	1406-3521-000

#### Active High Flow Specific Parts

17a	Connector, high flow M30 thread	1406-3557-000
18	Orifice, high flow	1407-3920-000

#### Active Low Flow with EVAC connector Specific Parts

17b	Connector, low flow EVAC	1406-3597-000
18	Orifice, low flow	1407-3919-000

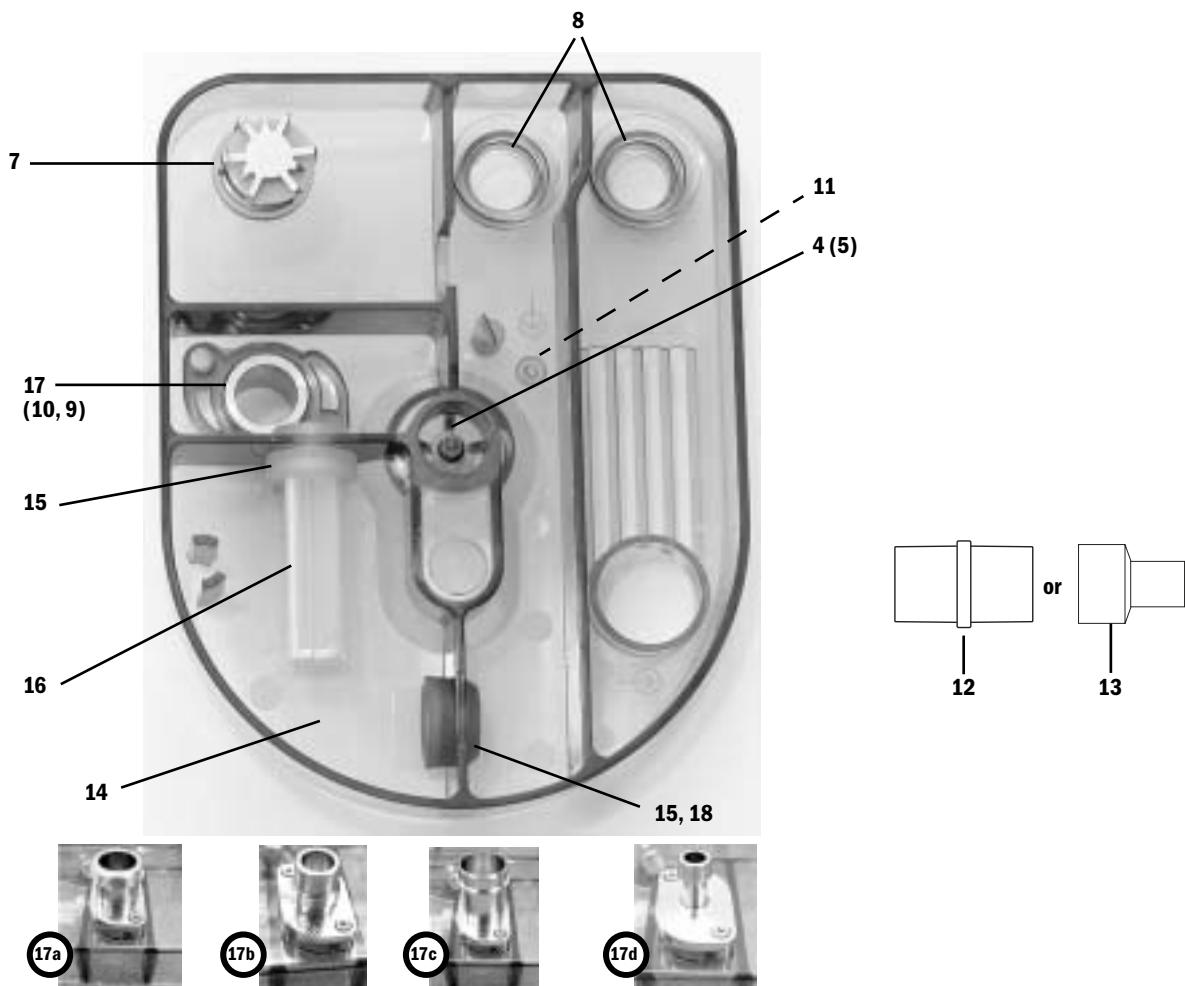
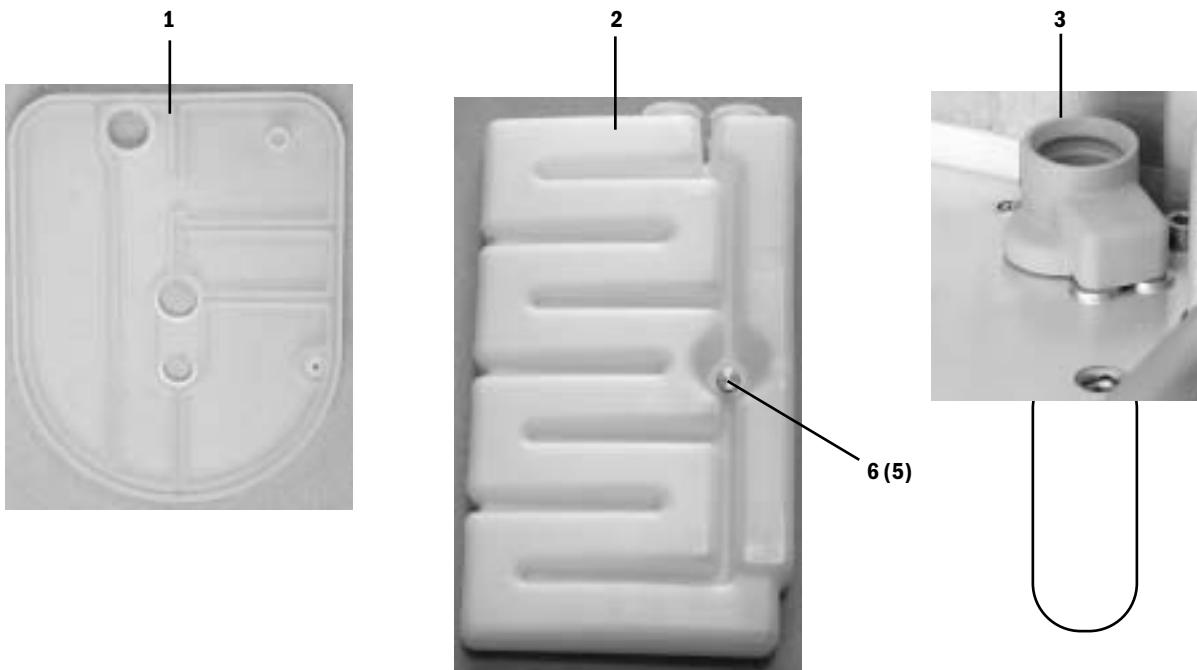
#### Active Low Flow with 25 mm connector Specific Parts

17c	Connector, low flow 25 mm	1406-3573-000
18	Orifice, low flow	1407-3919-000

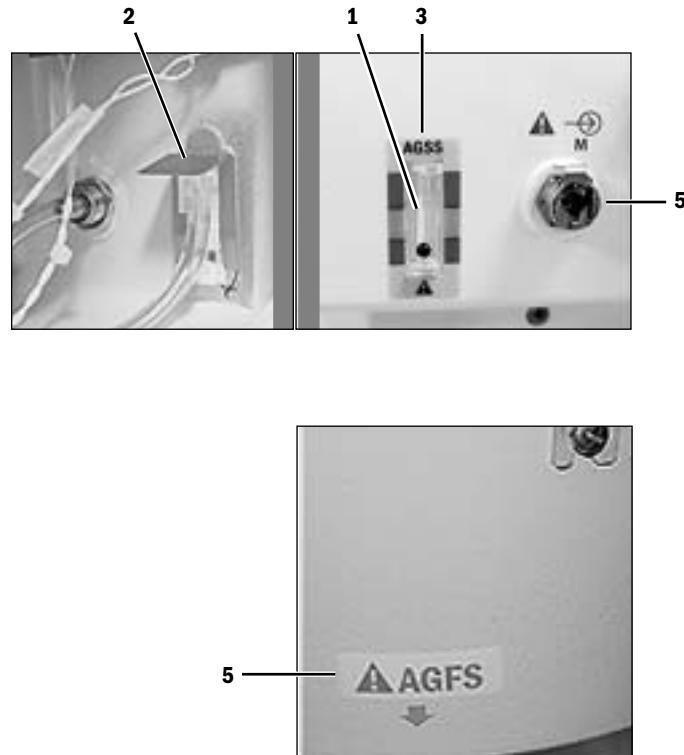
#### Active Low Flow with 12.7 mm hose barb connector Specific Parts

17d	Connector, low flow 12.7 mm (1/2 inch)	1406-3574-000
18	-none-	

\* Lubricate sparingly with Krytox



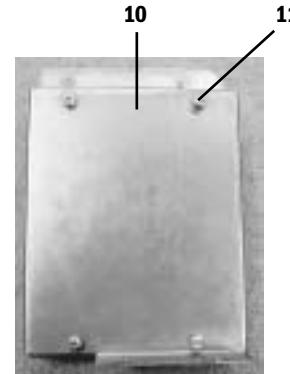
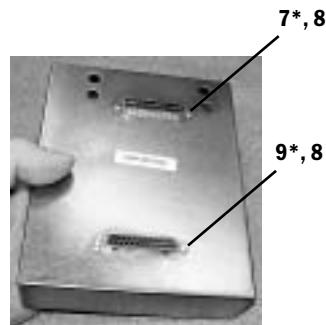
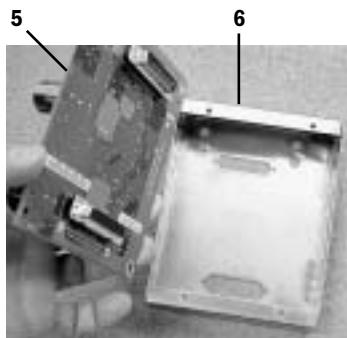
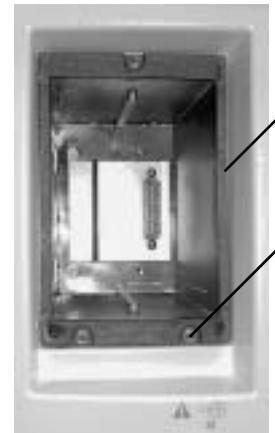
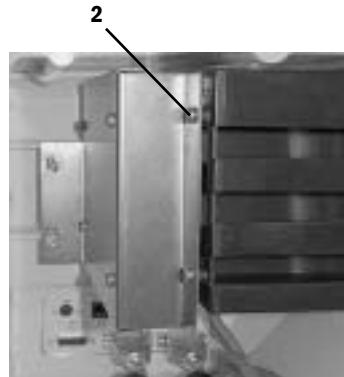
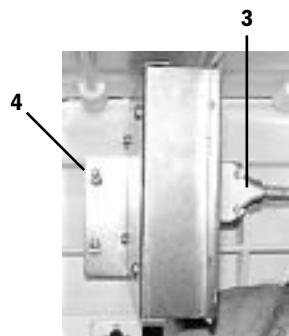
## 10.23 AGSS gauge, and sample return



Item	Description	Stock Number
1	Flowtube, AGSS	1406-3560-000
2	Clip, AGSS flowtube	1009-3181-000
3	Label, flow indicator AGSS Label, flow indicator AGFS (for German variant) Label, blank (for machines without flow indicator)	1406-3527-000 1009-3301-000 1009-3241-000
4	Label, AGFS (for German variant)	1009-3300-000
5*	Coupling, Colder (includes mounting nut)	1009-3134-000

\* Apply Loctite 242.

### 10.23.1 Airway module (MGAS) components

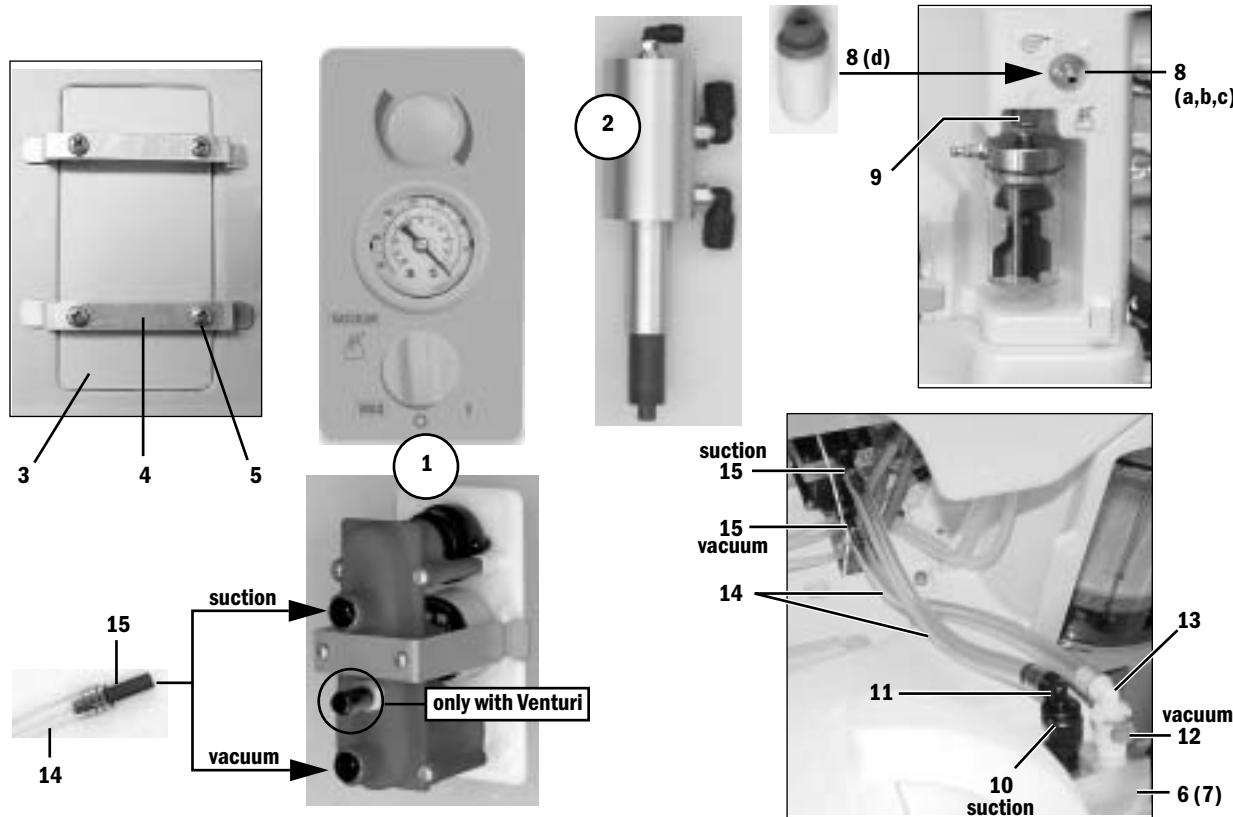


Item	Description	Stock Number
1	Guide, MGAS module	1009-3072-000
2	Screw, M4x8	1006-3178-000
3	Cable, MGAS to Connector board	1009-5555-000
4	Screw, M4x12 THD FORMING	1009-3109-000
5	MGAS monitoring board	1009-5573-000
6	Box, MGAS power supply	1009-3092-000
7*	Screw, 4-40	0140-6617-103
8	Lockwasher, #4 split	0144-1104-331
9*	Standoff	1504-3007-000
10	Cover, MGAS power supply	1009-3093-000
11	Screw, M4x8	0140-6226-113

\* Apply Loctite 242.

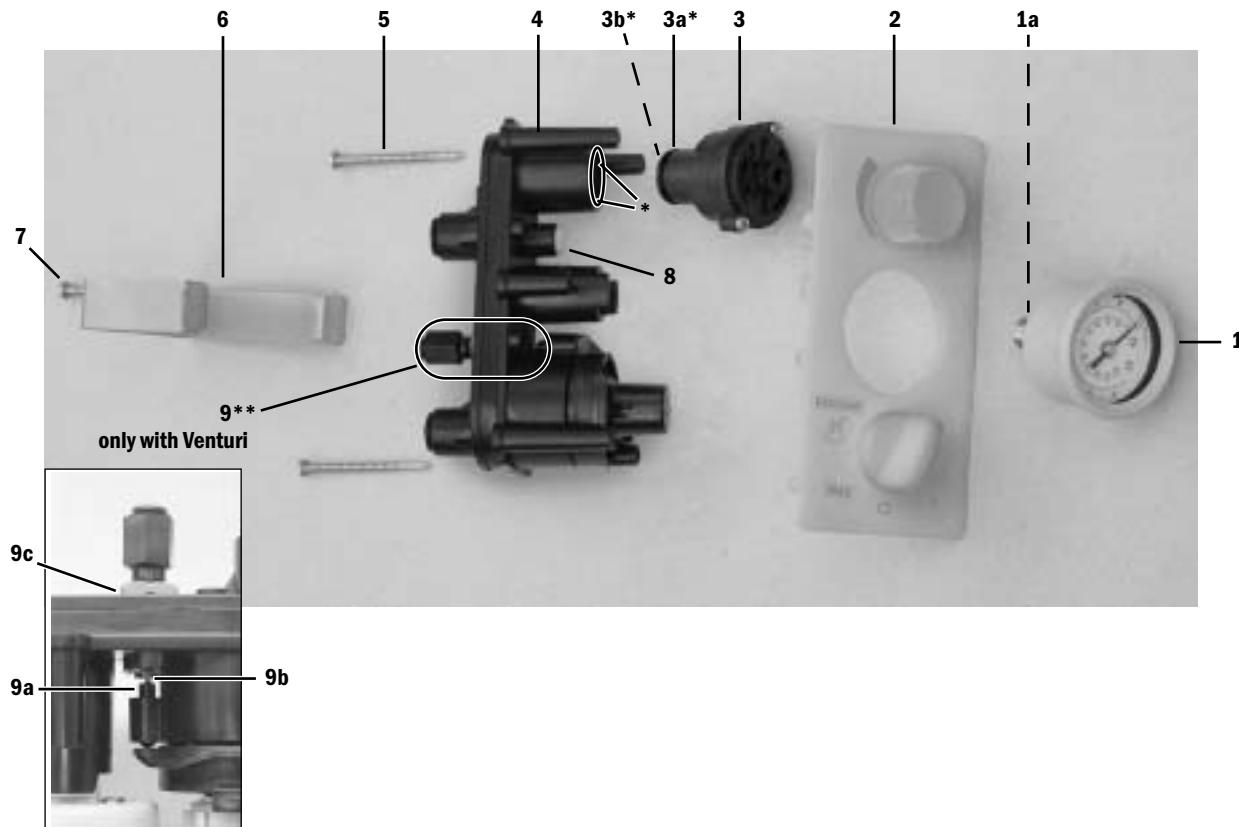
## 10.24 Integrated Suction Regulator

### 10.24.1 Major Components (Continuous and Venturi suction)



Item	Description	Stock Number
1	Suction Control Module	Refer to section 10.24.2
2	Venturi Assembly	Refer to section 10.24.3
3	Cover, blank (if no Suction)	1009-3271-000
4	Bracket, blank cover mounting	1009-3270-000
5	Screw, M4x10 self-tapping	1009-5534-000
6	Manifold	1009-3123-000
7	Screw, M5x20 BHSCS PT THD FORMING	1009-3384-000
8a	Connector, NIST	1011-3524-000
8b	Connector, Barb	0221-0702-300
8c	Connector, Air Liquide	1009-8292-000
8d	Muffler, for Venturi Drive	1011-3511-000
9	Coupling, Colder insert metal	1009-3135-000
10	Coupling, Colder body black	1009-3373-000
11	Coupling, Colder insert black	1009-3374-000
12	Coupling, Colder body white	1009-3371-000
13	Coupling, Colder insert white	1009-3372-000
14	Tubing, Tygon	Refer to section 10.33
15	Fitting, barb to 8-mm Legris	1009-3137-000

## 10.24.2 Suction Control Module

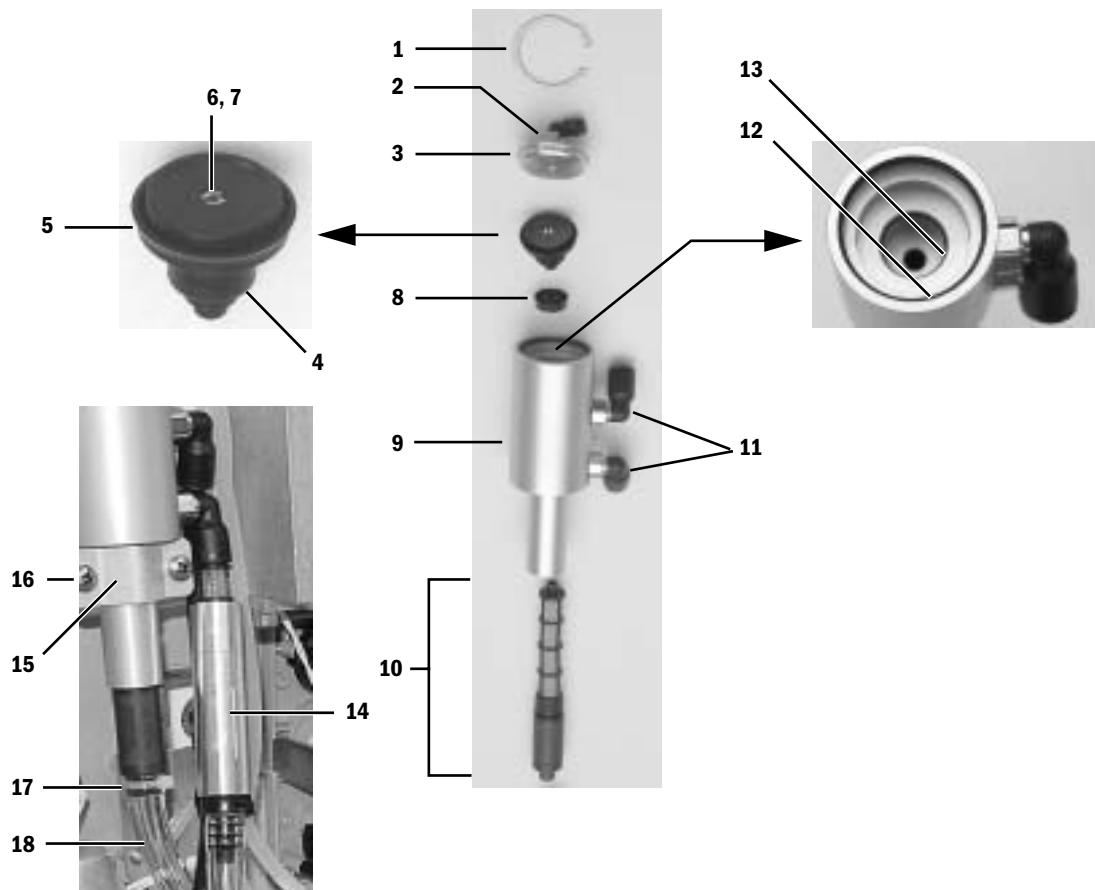


Item	Description	Stock Number
1	Gauge, 760 mmHg	1009-3227-000
	Gauge, 1 Bar	1009-3228-000
1a	O-ring, Gauge (included with gauge assy, 2ea. required)	6700-0133-500
2	Control panel assembly, with suction regulator knob and mode control knob	1009-3213-000
3	Regulator Module (plugs into manifold assembly)	6700-1225-800
3a	O-ring, Regulator Module, Stem (included with regulator module)	0210-0527-300
3b	O-ring, Regulator Module, Large (included with regulator module)	6700-0136-500
4	Manifold Assembly, without Gauge and Regulator Module	1009-3277-000
5	Screw, #6 - 2 inch	1009-3340-000
6	Mounting bracket	1009-3255-000
7	Screw, #6 - 1 inch	1009-3339-000
8	Filter	0206-5159-300
9	Pilot valve adapter assembly (includes plunger, jam nut, and valve assembly)	1009-3278-000

\* Lubricate the regulator module o-rings and the mating bore of the manifold sparingly with Dow 111 lubricant.

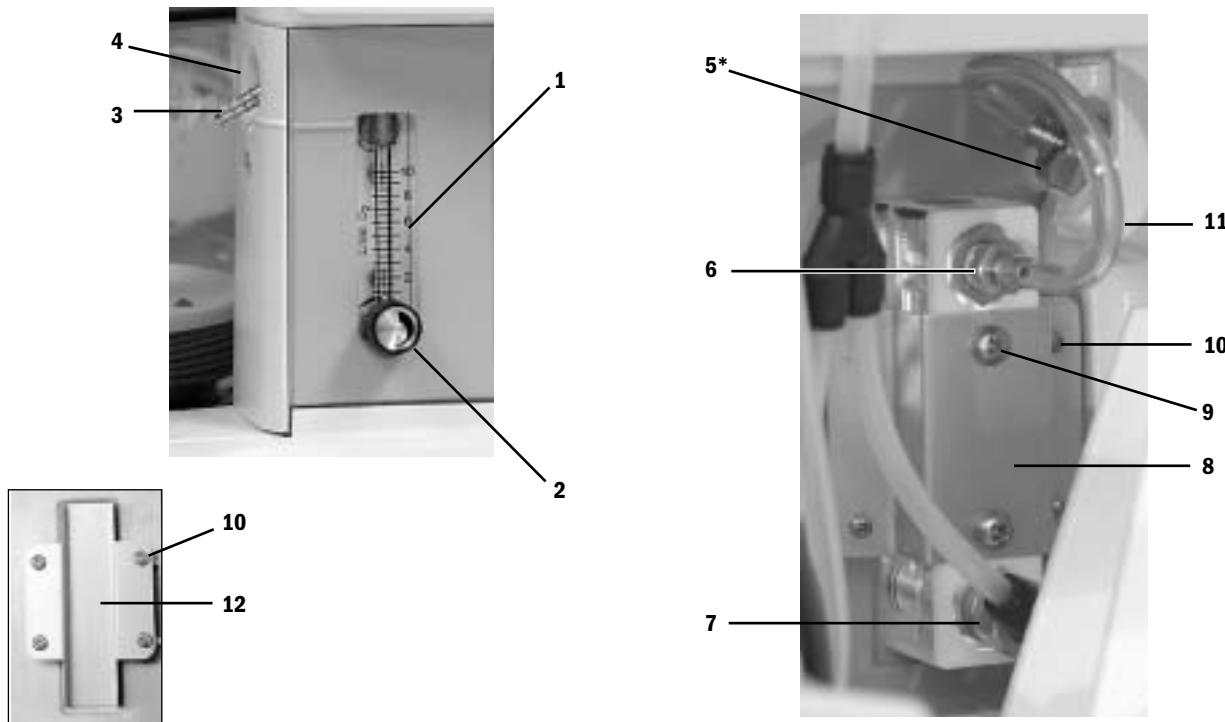
\*\* Drop the plunger (9a), round end first, into the manifold. Thread the pilot valve into the manifold body. Set the mode switch to raise the plunger. Adjust the pilot valve (9b) so that the plunger actuates the pilot valve approximately half of its travel. Tighten the jam nut (9c).

### 10.24.3 Venturi assembly



Item	Description	Stock Number
1	C-clip retainer, Truarc	1500-3158-000
2	Elbow fitting, 4-mm Legris	1006-3663-000
3	Cap	1011-5002-000
4	Spoppet	1011-5001-000
5	Seal, u-cup large	1503-3090-000
6	Orifice	1011-3508-000
7	Screen, 150 mesh monel	1001-3808-000
8	Seal, u-cup small	1503-3089-000
9	Body	1011-5000-000
10	Venturi	1011-3509-000
11	Elbow fitting, 8-mm Legris	1011-3510-000
12	O-ring, large	9221-3032-116
13	O-ring, small	1503-3108-000
14	Check valve	1011-8002-000
15	Bracket, Venturi mounting	1009-3182-000
16	Screw, M5x20 BHSCS PT THD FORMING	1009-3384-000
17	Cable tie	0203-5915-300
18	Tubing, Tygon	Refer to section 10.32

## 10.25 Auxiliary O<sub>2</sub> Flowmeter

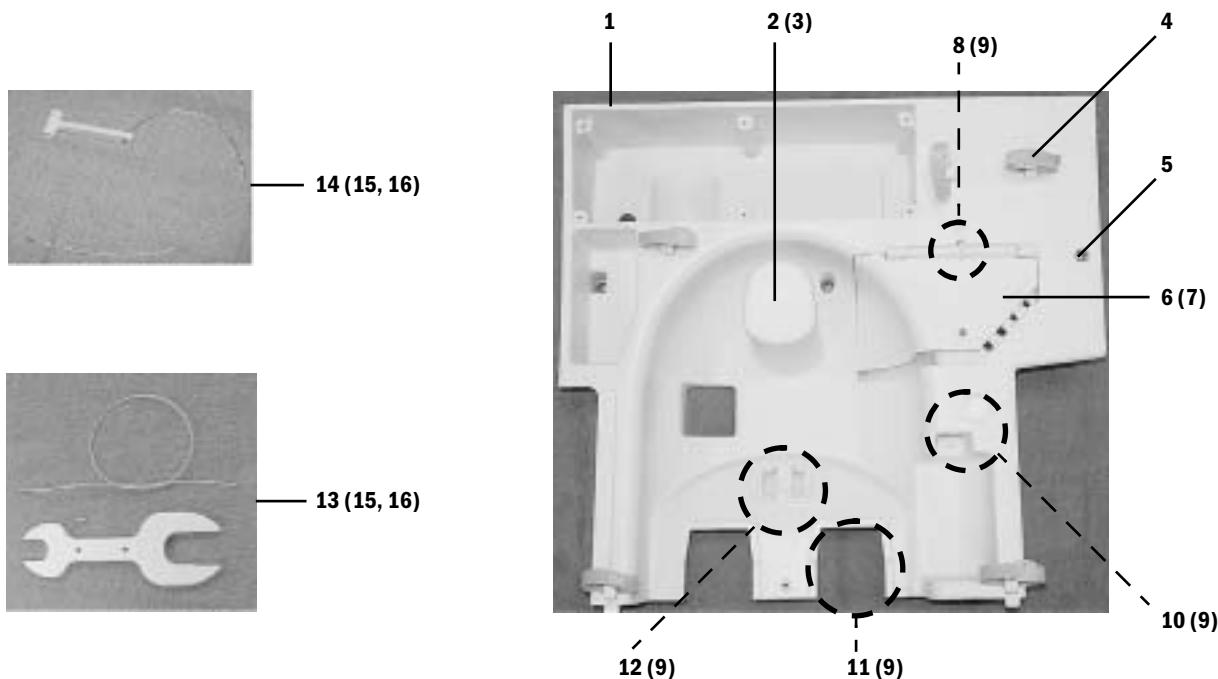


Item	Description	Stock Number
1	Flowmeter, 1-10 L/min, Complete with fittings installed	1006-8424-000
	Flowmeter, 1-10 L/min, without fittings	1006-3841-000
2	Knob, gray	1011-3471-000
3	Nipple, Panel-Mount, Auxiliary O <sub>2</sub> Outlet	1006-5177-000
4	Label, blank (if no Auxiliary O <sub>2</sub> )	1009-3243-000
5*	Nut, M12x1.75, SST	0144-3132-140
6**	Flowmeter Fitting, 1/8 NPTM straight adapter	0204-8877-300
	Flowmeter Fitting, 1/8 NPTM elbow adapter	0204-8788-300
7	Flowmeter Fitting Assembly, 6-mm Tubing Adapter	1006-8423-000
8	Plate, Flowmeter Mounting	1009-3126-000
9	Screw, 10-32 x 3/8	0140-6631-107
10	Screw, M3x8, SST	1009-5534-000
11	Tubing (low-pressure) 250 mm - 1/4 inch	1605-1001-000
12	Plate, blank (if no Auxiliary O <sub>2</sub> )	1009-3128-000

\* Apply Loctite 242.

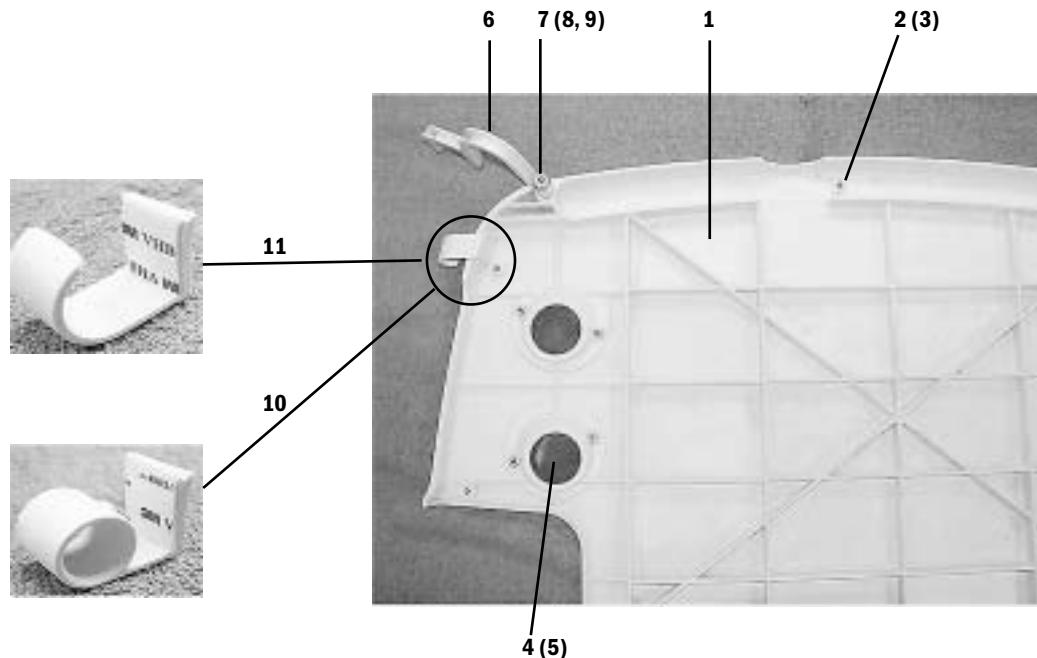
\*\* Apply Teflon tape.

## 10.26 Rear panel components



Item	Description	Stock Number
1	Cover, rear upper	1009-3073-000
2	Cap, hose reel	1009-3075-000
3	Screw, M5x20 BHSCS PT THD FORMING	1009-3384-000
4	Strap, hook/loop	1009-3233-000
5	Screw, M6x1.0 captive	1009-3114-000
6	Door, access	1009-3074-000
7	Screw, M4x12	1009-3109-000
8	Spring, cantilever	1009-3124-000
9	Screw, M3x8	0142-4254-106
10	Cover, trap bottle (if no internal suction)	1009-3173-000
11	Cover, regulator yoke (if no regulator)	1009-3121-000
12	Plate, clip cover	1009-3185-000
13	Wrench, DIN cylinder (with cable)	1202-3651-000
14	Wrench, pin index cylinder (with cable)	0219-3415-800
15	Cable	1010-3049-000
16	Ferrule, cylinder wrench cable retainer	1001-3708-000

## 10.27 Tabletop components



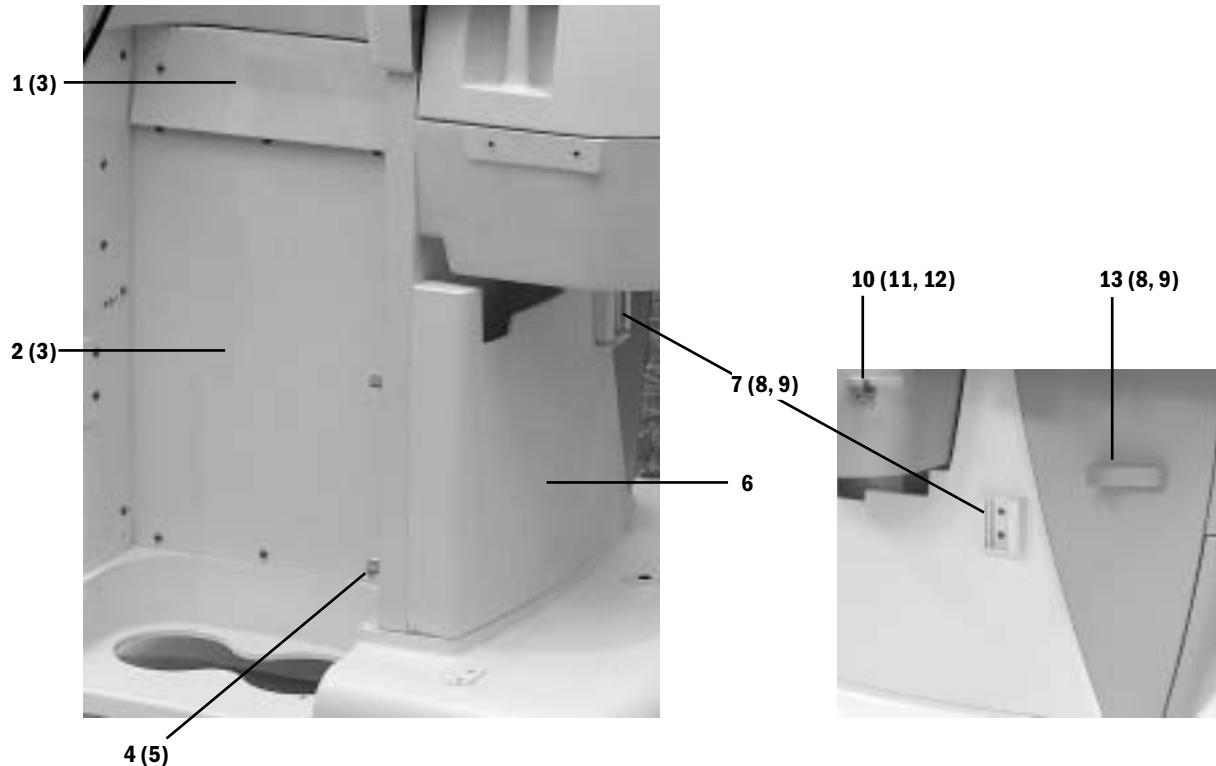
Item	Description	Stock Number
1	Tabletop, work surface	1009-3029-000
2	Screw, relieved	1504-3001-000
3	Washer, retainer	1009-3178-000
4	Window, check-valve	1009-3088-000
5	Palnut	1009-3090-000
6	Hook, breathing circuit	1009-3086-000
7	Bolt, shoulder	1009-3172-000
8	Washer, wave	1009-3035-000
9	Washer, Nylon	1009-3150-000
10	Clip, with tape (used with bag arm)	1009-8196-000
11	Clip, with tape (used with bag on hose)	1009-8197-000

## 10.28 Right-side Components



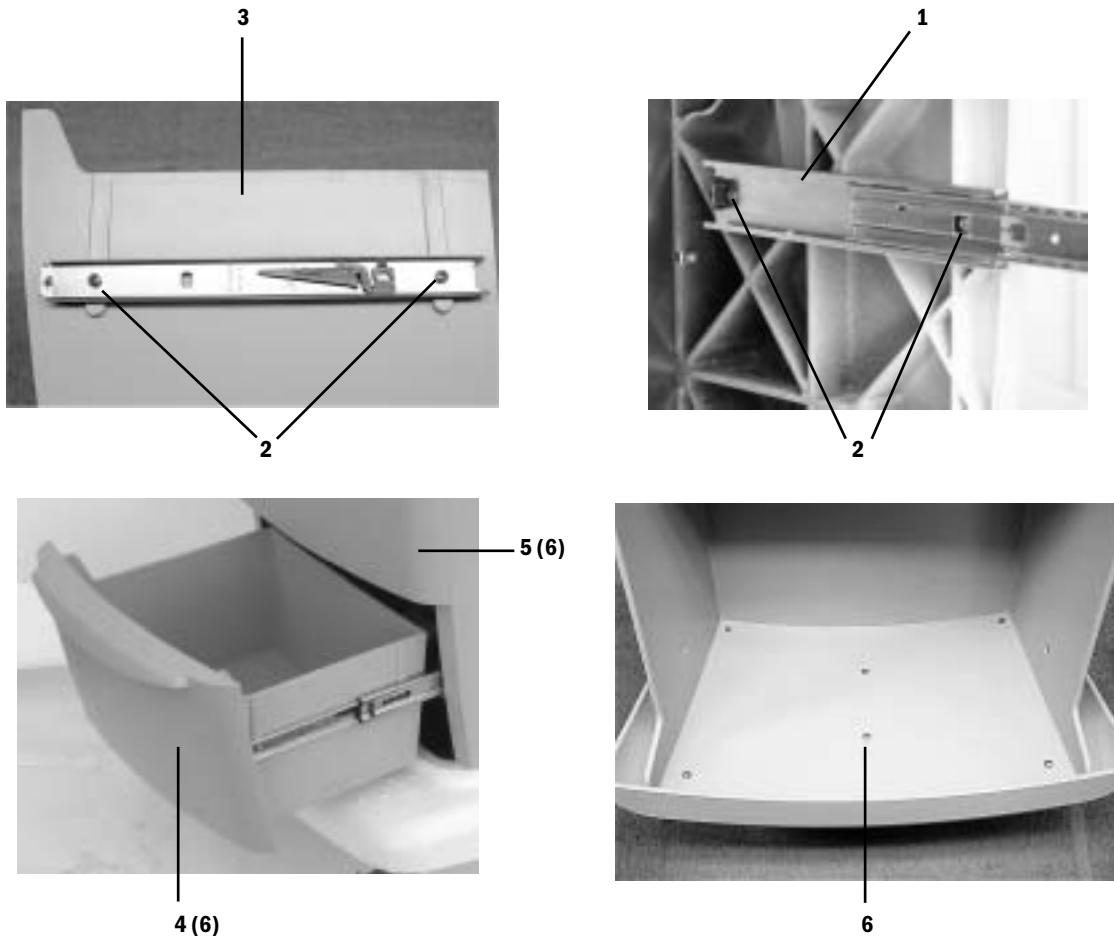
Item	Description	Stock Number
1	Extrusion cover	1009-3021-000
2	Screw, M6x20	0144-2131-921
3	Lockwasher, M6 internal	0144-1118-130
4	Dovetail, RH upright	1009-3129-000
5	Screw, self tapping	1009-5534-000
6	Cover, pipeline inlet	1009-3091-000
7	Screw, M6x14	1006-3178-000

## 10.29 External components - lower assembly



Item	Description	Stock Number
1	Panel, access	1009-3059-000
2	Panel, service	1009-4141-000
3	Screw, M4x8	1006-3178-000
4	Thumbscrew	1406-3304-000
5	Ring, retaining	1406-3319-000
6	Cover, scavenger reservoir	1009-3027-000
7	Bracket, suction reservoir	1009-3107-000
8	Screw, M4x16	9211-0440-163
9	Lockwasher, M4 external	9213-0540-003
10	Clip, suction bag hose	1407-3327-000
11	Screw, M5x16 PAN HD	9211-8350-163
12	Lockwasher, M5 external;	0144-1118-220
13	Bumper, absorber	1009-3105-000

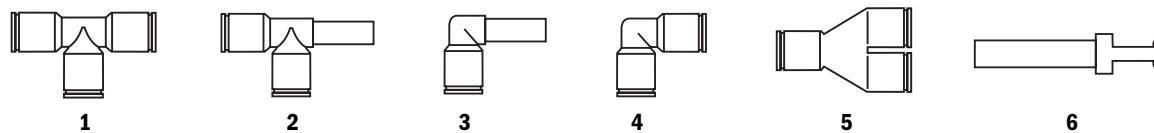
## 10.30 Drawer



Item	Description	Stock Number
1	Slide, drawer	1009-3084-000
2	Screw, M4x8 Nyloc	1009-3183-000
3	Drawer, body	1009-3078-000
4	Drawer Front, lower (with down arrow on back)	1009-3032-000
5	Drawer Front, upper (with up arrow on back)	1009-3031-000
6	Screw, M4x12	1009-3109-000

## 10.31 Fittings and tubing charts

### 10.31.1 Legris quick-release fittings



CS.07.125,27,44,45,46,47

Item	Description	Stock Number
1	<b>Tees – (tube/tube/tube)</b> 4 mm (N <sub>2</sub> O) 6 mm (O <sub>2</sub> ) 8 mm (Air) 8mm/6mm/8mm (SCGO pilot)	1202-3653-000 1006-3544-000 1006-3545-000 1009-3297-000
2	<b>Tees – (tube/tube/standpipe)</b> 6 mm (O <sub>2</sub> )	1006-3862-000
3	<b>Elbow – (tube/standpipe)</b> 4 mm (N <sub>2</sub> O) 6 mm (O <sub>2</sub> ) 8 mm (Air) 1/4 inch (mixed gas)	1006-3533-000 1006-3534-000 1006-3535-000 1006-3737-000
4	<b>Elbow – (tube/tube)</b> 1/4 inch (mixed gas)	1202-3804-000
5	<b>Y</b> 6 mm (O <sub>2</sub> ) 8 mm (Air)	1009-3043-000 1009-3044-000
6	<b>Plug</b> 4 mm (N <sub>2</sub> O) 6 mm (O <sub>2</sub> ) 8 mm (Air)	1006-3530-000 1006-3531-000 1006-3532-000

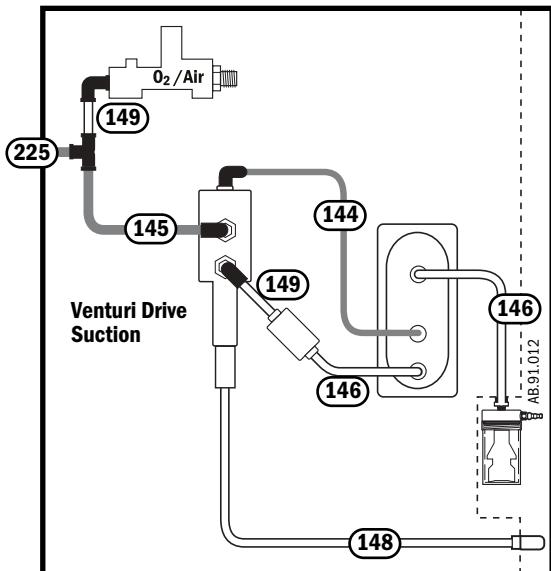
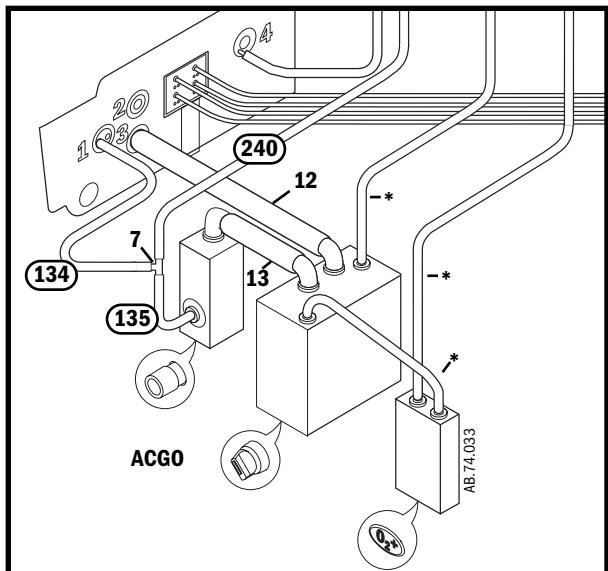
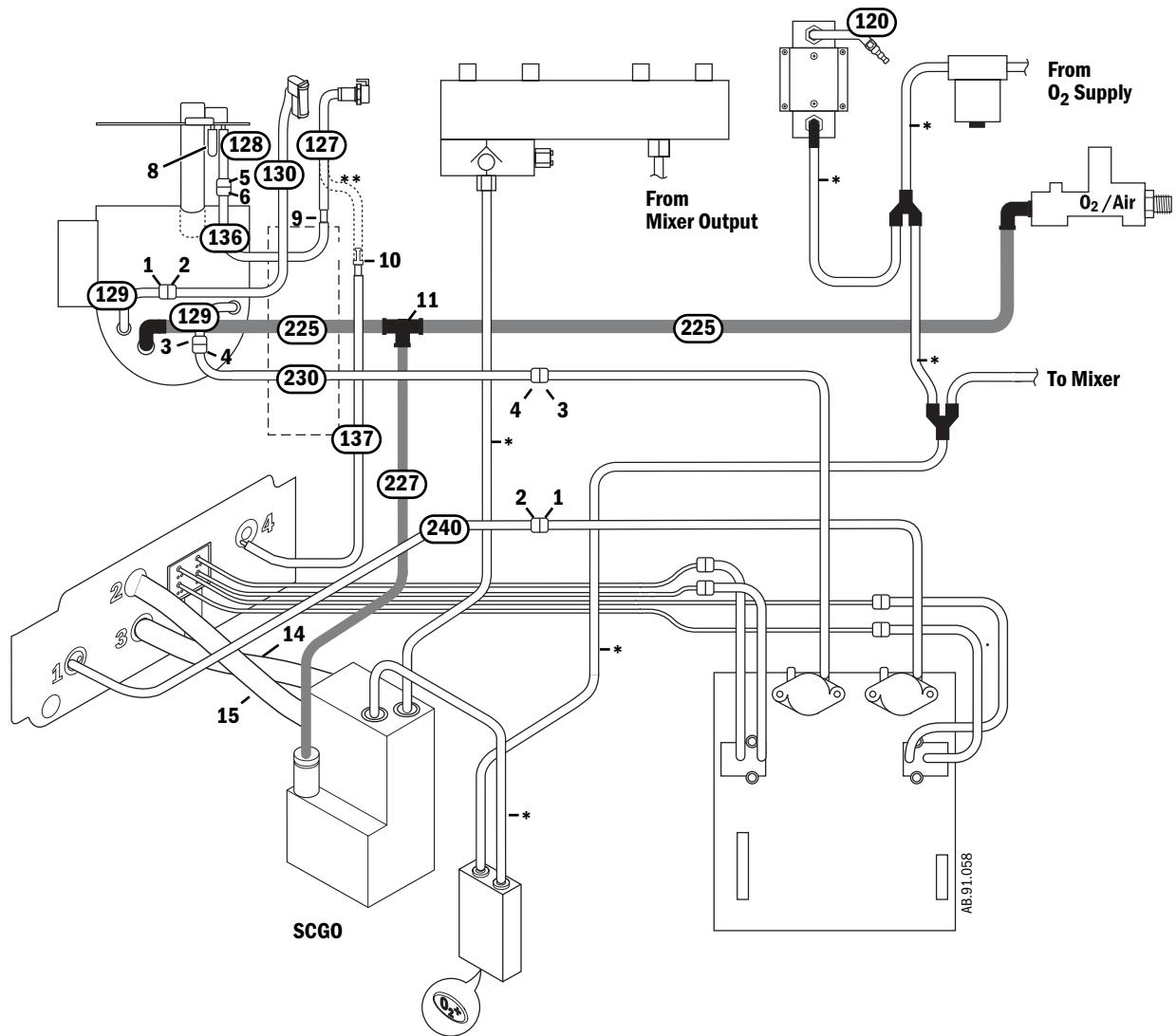
## 10.32 Vent Drive and low-pressure tubing

Item	Description	Length – Size	Stock Number
1	Coupler, female - black		1503-3128-000
2	Coupler, male - black		1503-3237-000
3	Coupler, female - white		1503-3119-000
4	Coupler, male - white		1503-3236-000
5	Coupler, female - yellow		1503-3132-000
6	Coupler, male - yellow		1503-3131-000
7	Tee (male barb)		1009-3011-000
8	Cap, plug		1406-3524-000
9	Fitting, coupler barb ends		1009-3077-000
10	Plug, 4-mm		1006-3530-000
11	Tee (8mm/6mm/8mm)		1009-3297-000
12	Tubing (silicone)	72 mm - 3/8 inch	1009-3164-000
13	Tubing (silicone)	42 mm - 3/8 inch	1009-3164-000
14	Tubing (silicone)	100 mm - 3/8 inch	1009-3164-000
15	Tubing (silicone)	110 mm - 3/8 inch	1009-3164-000

	Tube Markings (factory build only)		Length – Size	
120	Aux O2 OUT	(low-pressure)	250 mm - 1/4 inch	1605-1001-000
127	RGM return	(low-pressure)	750 mm - 1/4 inch	1605-1001-000
128	unmarked	(low-pressure)	300 mm - 1/4 inch	1605-1001-000
129	unmarked	(low-pressure)	151 mm - 1/4 inch	1605-1001-000
130	AGSS flowtube	(low-pressure)	750 mm - 1/4 inch	1605-1001-000
134	unmarked	(low-pressure)	25 mm - 1/4 inch	1605-1001-000
135	unmarked	(low-pressure)	50 mm - 1/4 inch	1605-1001-000
136	RGM to Scavenge	(low-pressure)	200 mm - 1/4 inch	1605-1001-000
137	RGM to Circuit	(low-pressure)	300 mm - 1/4 inch	1605-1001-000
144	Venturi Pilot	(black)	330 mm - 4 mm	1009-3363-000
145	Venturi Drive	(black)	300 mm - 8 mm	1009-3296-000
146	unmarked		260 mm - Tygon	6700-0005-300
148	unmarked		465 mm - Tygon	6700-0005-300
149	unmarked		40 mm - 8 mm	1001-3063-000
225	VENT DRIVE	(black)	440 mm - 8 mm	1009-3296-000
227	SCGO PILOT	(black)	320 mm - 6 mm	1009-3295-000
230	MANIFOLD PRESS	(low-pressure)	300 mm - 1/4 inch	1605-1001-000
240	PAW	(low-pressure)	500 mm - 1/4 inch	1605-1001-000

\* Refer to section 10.33

\*\* Sample gas return is directed to the scavenging system as a factory default. A qualified service representative can reroute the sample gas back to the breathing system (refer to Section 9.23).



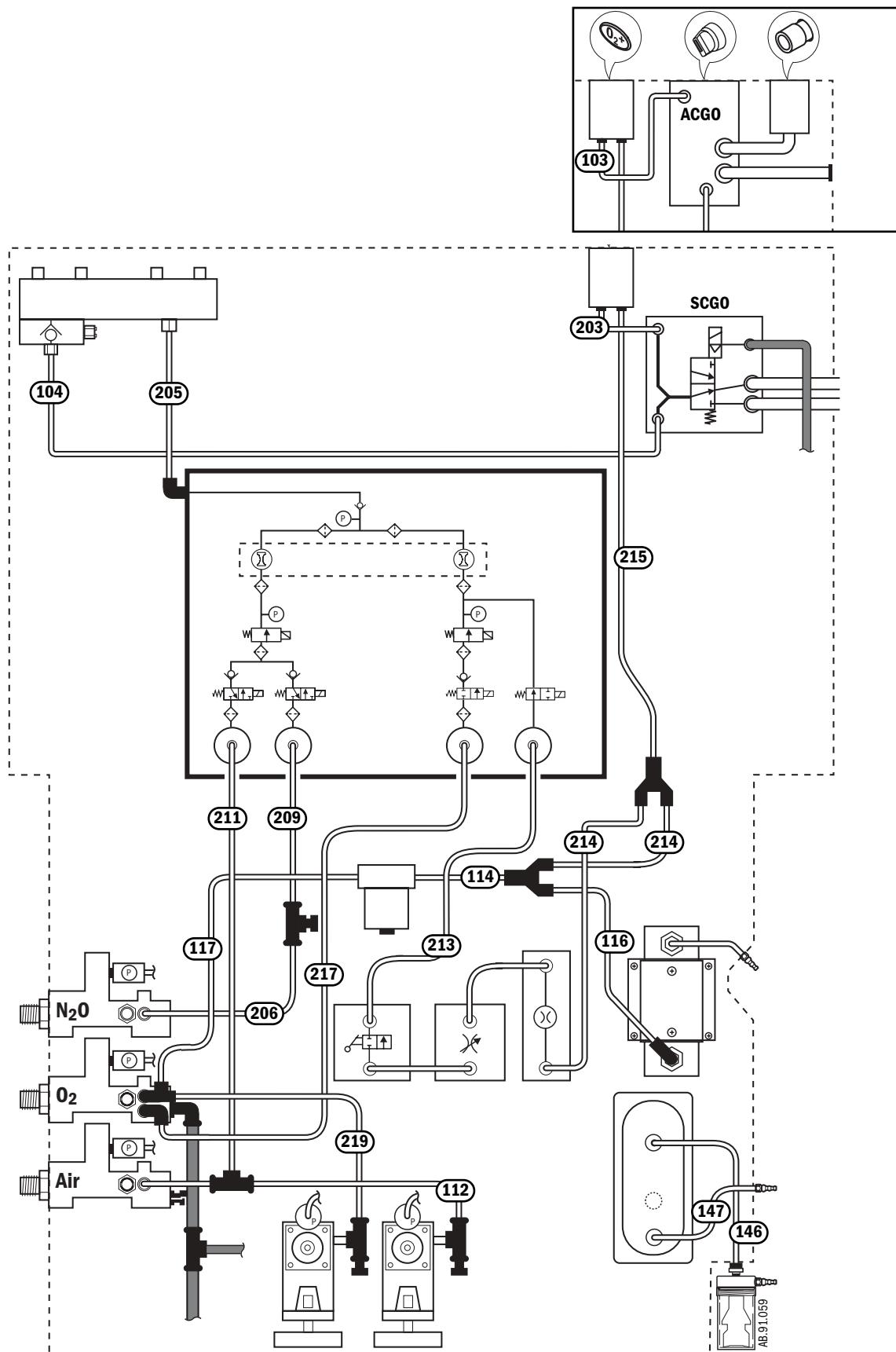
## 10.33 Tubing for use with Legris fittings

Except for the Tygon tubing (Items 146 and 147), this tubing is a flexible, Nylon-type tubing for use with quick-release fittings.

Item	Description	Length – Size	Stock Number
<b>Tube Markings (factory build only)</b>			
206	N2O PLINE	230 mm - 4 mm	1001-3060-000
208*	N2O CYL	330 mm - 4 mm	1001-3060-000
209	N2O PLINE - MIXER	430 mm - 4 mm	1001-3060-000
114	REGULATED O2	400 mm - 6 mm	1001-3062-000
116	REGULATED O2	250 mm - 6 mm	1001-3062-000
117	O2 PLINE - REG IN	330 mm - 6 mm	1001-3062-000
123**	unmarked	175 mm - 6 mm	1001-3062-000
213	REGULATED O2	560 mm - 6 mm	1001-3062-000
214	REGULATED O2	270 mm - 6 mm	1001-3062-000
215	REGULATED O2	300 mm - 6 mm	1001-3062-000
217	O2 PLINE - MIXER	580 mm - 6 mm	1001-3062-000
219	O2 CYL - O2 PLINE	215 mm - 6 mm	1001-3062-000
112	AIR CYL- AIR PLINE	270 mm - 8 mm	1001-3063-000
211	AIR PLINE - MIXER	460 mm - 8 mm	1001-3063-000
103	FLUSH VLV-ACGO	280 mm - 1/4 inch	1001-3064-000
104	VAP OUT- ACGO	840 mm - 1/4 inch	1001-3064-000
146	unmarked	260 mm - Tygon	6700-0005-300
147	unmarked	290 mm - Tygon	6700-0005-300
203	FLUSH VLV-SCGO	110 mm - 1/4 inch	1001-3064-000
205	MIXER - VAP IN	600 mm - 1/4 inch	1001-3064-000

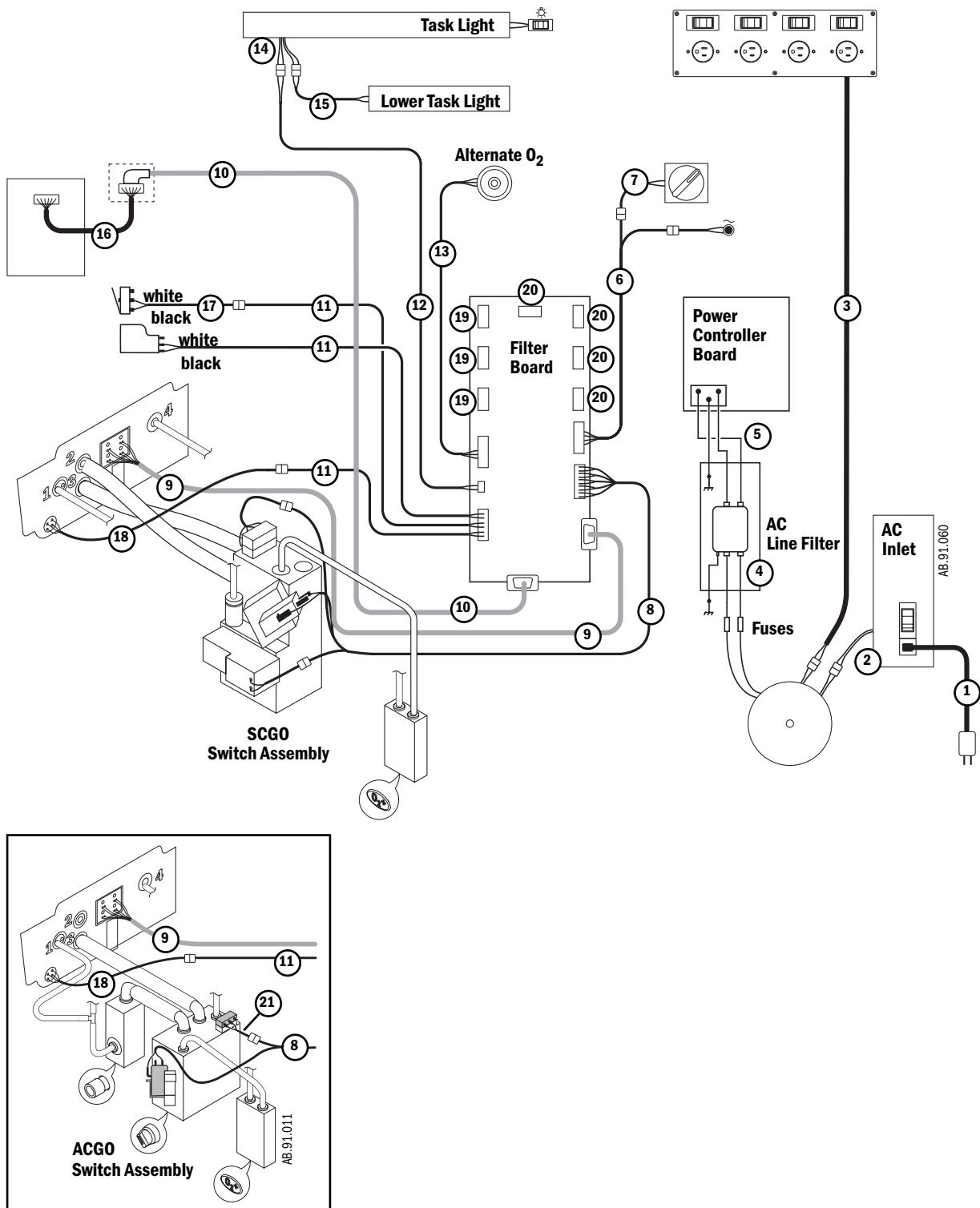
\* With an N<sub>2</sub>O cylinder supply, Item 208 connects the N<sub>2</sub>O cylinder supply to the Tee connector between Items 206 and 209.

\*\* With two inboard O<sub>2</sub> cylinder supplies, Item 123 connects the second O<sub>2</sub> cylinder supply to the first O<sub>2</sub> cylinder supply.



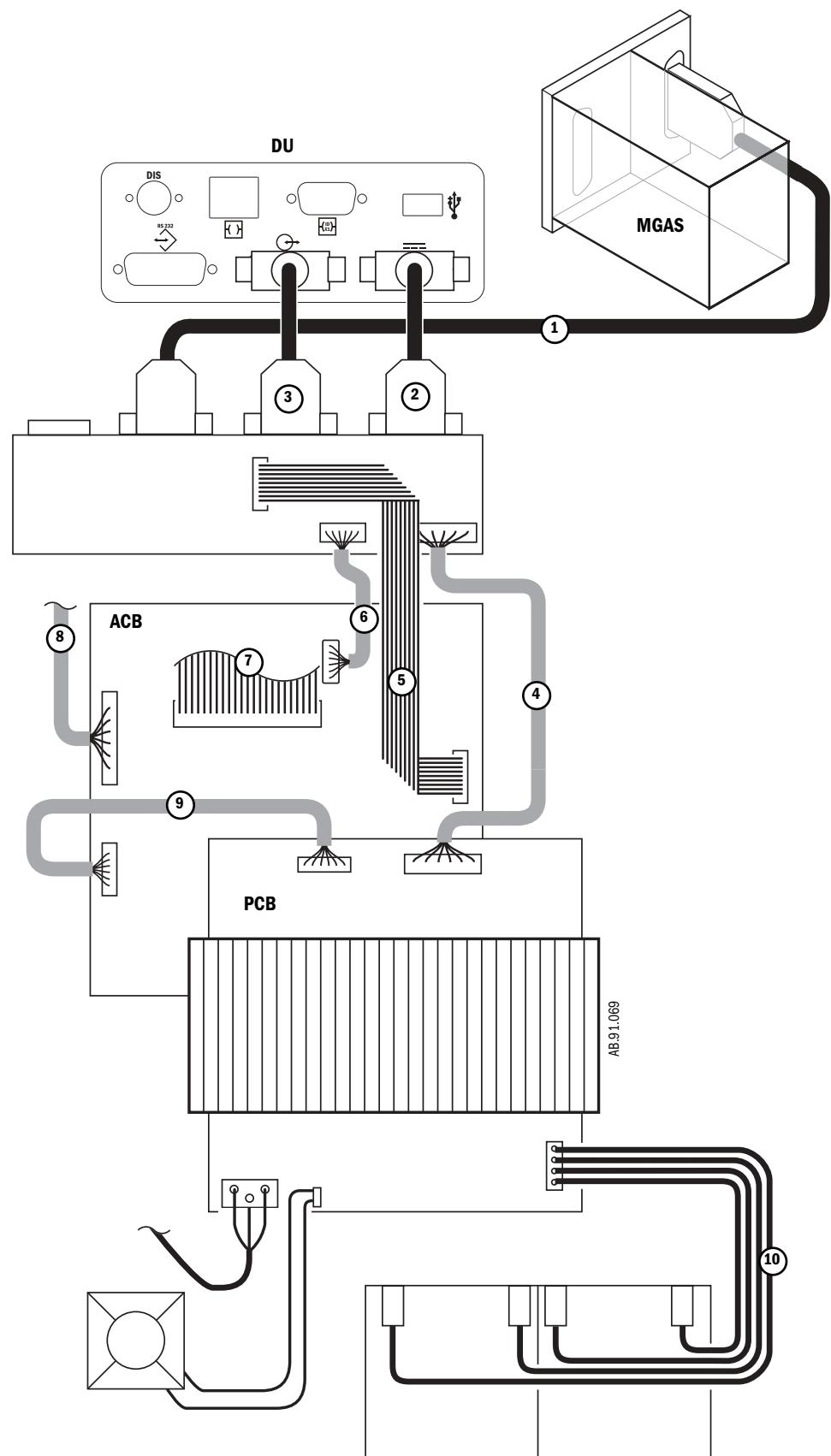
## 10.34 Cables and harnesses

<b>Item</b>	<b>Description</b>	<b>Stock Number</b>
1	Power Cord	Refer to section 10.5
2	Harness, 100/120 V to Toroid Harness, 220/240 V to Toroid	1009-5752-000 1009-5753-000
3	Harness, to 100/120 V outlets Harness, to 220/240 V outlets	1009-5716-000 1009-5717-000
4	Harness, fuse block to AC line filter	1009-5751-000
5	Harness, AC line filter to Power Controller Board	1009-5754-000
6	Harness, Filter Board to On/Standby switch and LED	1009-5538-000
7	Harness, On/Standby switch	1009-5542-000
8	Harness, Filter Board to SCGO/ACGO	1009-5528-000
9	Harness, Filter Board to ABS flow sensors (includes tubing)	1009-8223-000
10	Cable, Filter Board to Vent Engine harness connector	1009-5521-000
11	Harness, Filter Board to O <sub>2</sub> Cell and ABS switches	1009-5531-000
12	Harness, Filter Board to Task Lights	1009-5533-000
13	Harness, Filter Board to Alternate O <sub>2</sub> switch	1009-5532-000
14	Harness, Task Light	1009-5853-000
15	Harness, Lower Task Light	1009-5854-000
16	Harness, Vent Engine Board	1009-5545-000
17	Harness, Bag/Vent switch to Filter Board harness	1009-5585-000
18	Harness, O <sub>2</sub> Cell to Filter Board harness	1009-5586-000
19	Transducer, pipeline pressure (includes cable)	1011-3000-000
20	Transducer, cylinder pressure (includes cable)	1011-3001-000
21	Harness, ACGO switch to Filter Board harness	1009-5872-000



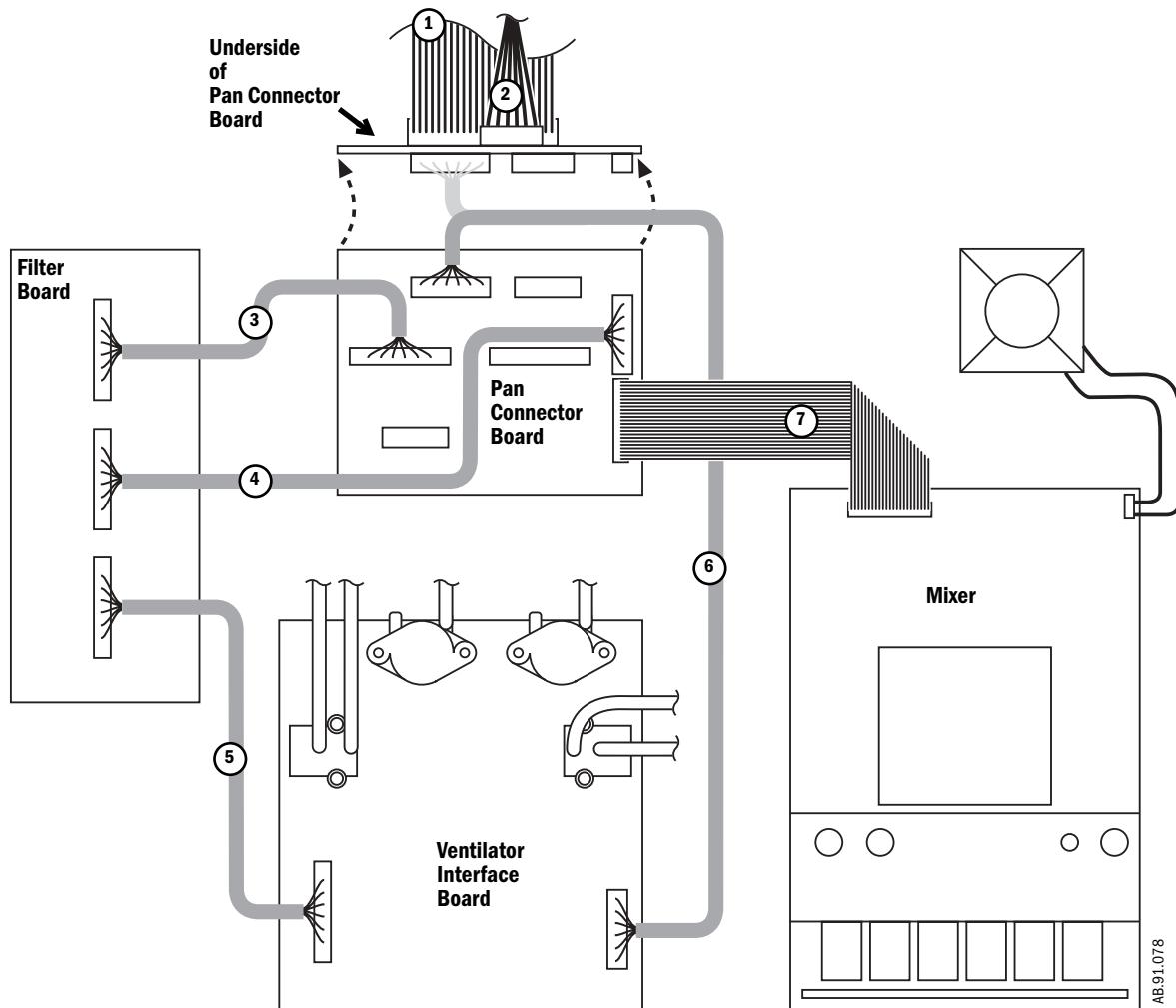
## 10.35 Cables and harnesses in lower electronic enclosure

<b>Item</b>	<b>Description</b>	<b>Stock Number</b>
1	Cable, to MGAS (Airway module) power supply	1009-5555-000
2	Cable, to Display Unit system power interface	1009-5571-000
3	Cable, to Display Unit system signal interface	1009-5572-000
4	Harness, J3-PCB to J5-DCB	1009-5552-000
5	Cable, ribbon J2-ACB to J9-DCB	1009-5561-000
6	Harness, J7-ACB to J6-DCB	1009-5556-000
7	Cable, ribbon J1-ACB to underside of Pan Connector Board	1009-5549-000
8	Harness, J3-ACB to underside of Pan Connector Board	1009-5560-000
9	Harness, J4-ACB to J4-PCB	1009-5551-000
10	Harness, battery	1009-5557-000



## 10.36 Cables and harnesses in Pan enclosure

<b>Item</b>	<b>Description</b>	<b>Stock Number</b>
1	Cable, ribbon J1-ACB to underside of Pan Connector board	1009-5549-000
2	Harness, J3-ACB to underside of Pan Connector board	1009-5560-000
3	Harness, Pan Connector board to Filter board, 24 POSN	1009-5544-000
4	Harness, Pan Connector board to Filter board, 12 POSN	1009-5543-000
5	Harness, Filter board to VIB	1009-5546-000
6	Harness, Pan Connector board to VIB	1009-5547-000
7	Cable, ribbon, Pan Connector board to Mixer	1009-5550-000



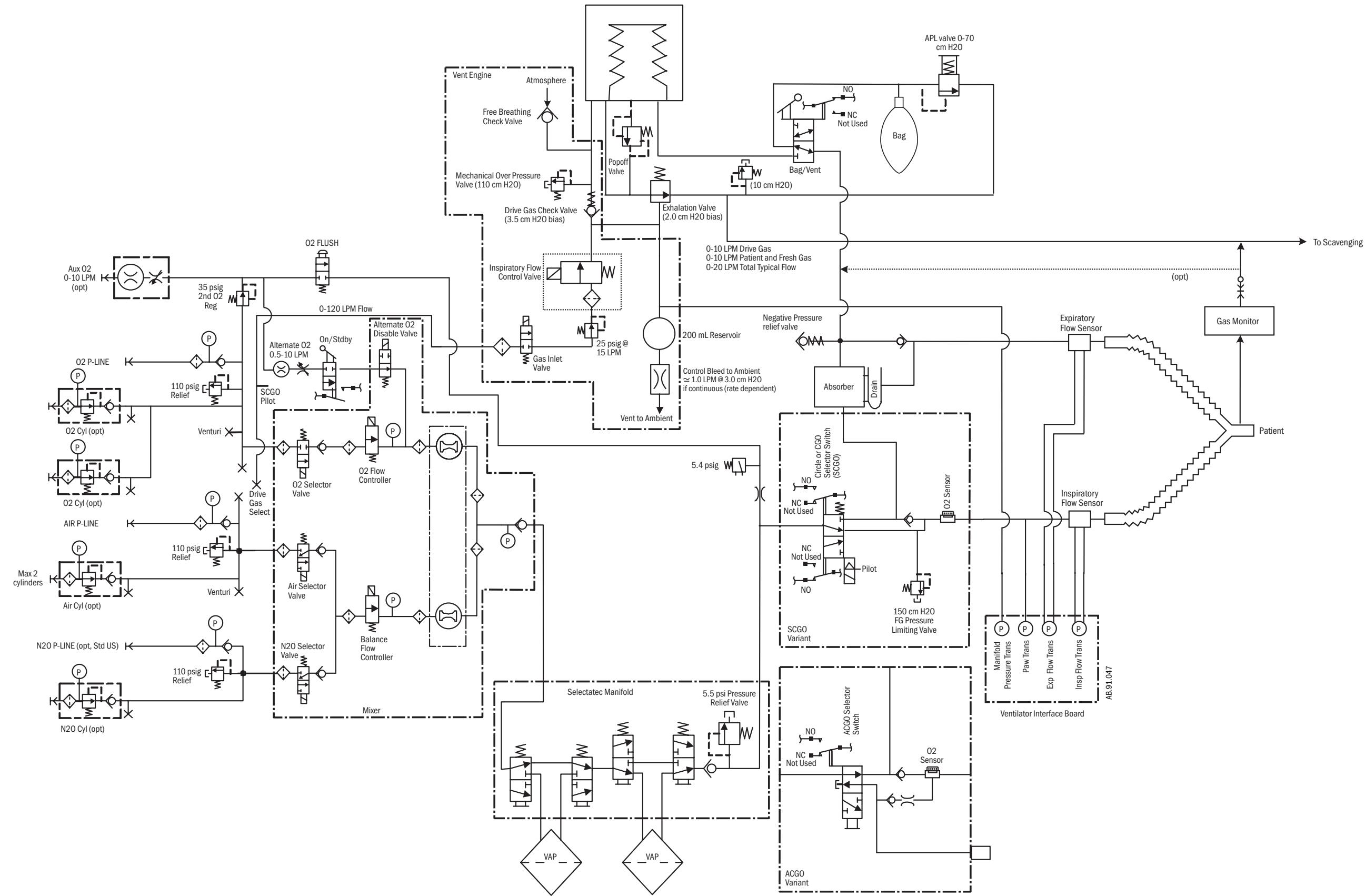
## Notes

# 11 Schematics and Diagrams

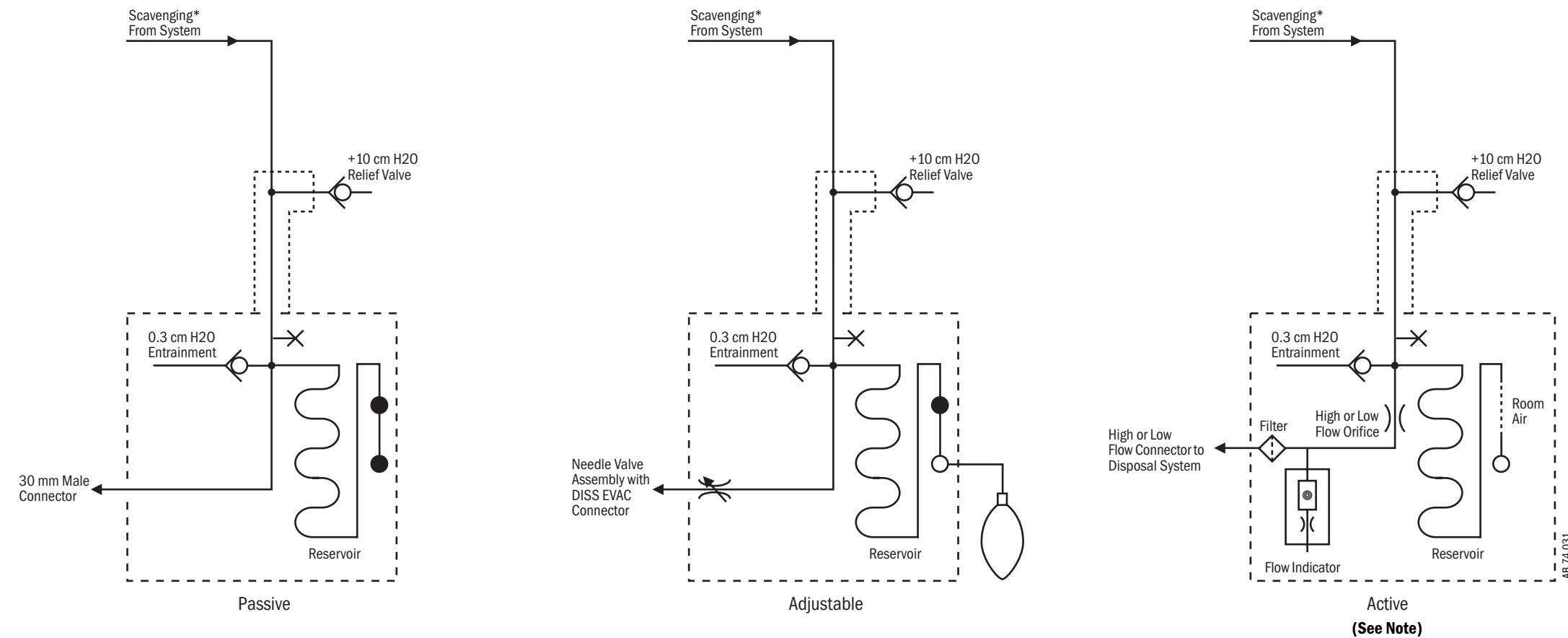
## In this section

Schematics are subject to change without notice.  
Circuit boards are available only as complete assemblies.

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*Figure 11-1 • System circuit diagram*



#### Key to Symbols

- ✗ = Plugged port (1/8 inch) for sample gas return.
- = Plugged port (30 mm) for auxiliary breathing system scavenging.
- = Open port (30 mm) for auxiliary breathing system scavenging.
- \* = 0 to 10 l/min drive gas, 0 to 10 l/min patient and fresh gas, 0 to 20 l/min total typical flow.

**Note:** Active AGSS systems with a 12.7 mm connector do not include the Flow Orifice and the Flow Indicator.

Figure 11-2 • Gas scavenging circuits

## Key to Numbered Components

1. Pipeline inlet
  2. Pipeline pressure transducer
  3. High-pressure relief valve (758 kPa / 110 psi)\*
  4. Supply connections for the ventilator and pilot pressure for SCGO
    - a. O<sub>2</sub> drive gas
    - b. Air drive gas
  5. Venturi suction supply connection
    - a. O<sub>2</sub> drive gas
    - b. Air drive gas
  6. Cylinder inlet
  7. Cylinder pressure transducer
  8. Primary regulator (cylinder pressure)
  9. Test port (primary regulator)
  10. System switch
  11. Selector valve
    - a = O<sub>2</sub>; b = Air; c = N<sub>2</sub>O
  12. Flow controller
    - a = O<sub>2</sub>; b = balance gas
  13. Alternate O<sub>2</sub> disable valve
  14. Hot-wire anemometer
    - a = O<sub>2</sub> flow sensor channel; b = balance gas flow sensor channel
  15. Vaporizer port valve
  16. Vaporizer
  17. Low-pressure relief valve (38 kPa / 5.5 psi)\*
  18. O<sub>2</sub> flush and auxiliary flowmeter regulator (241 kPa / 35 psi)\*
  19. O<sub>2</sub> Flush valve
  20. Pressure switch (used with the ventilator)
  21. Breathing system pressure relief valve (SCGO only – 150 cmH<sub>2</sub>O)\*
  22. To Port 3 of ABS interface (circle)
  23. For SCGO, to Port 2 of ABS interface (non-circle Inspiratory port)  
For ACGO, to external 22-mm ACGO connector
  24. Auxiliary O<sub>2</sub> flowmeter (optional)
- \* Approximate values

## Key to Symbols

- Pneumatic Connection
- Filter
- Direction of Flow
- Check Valve

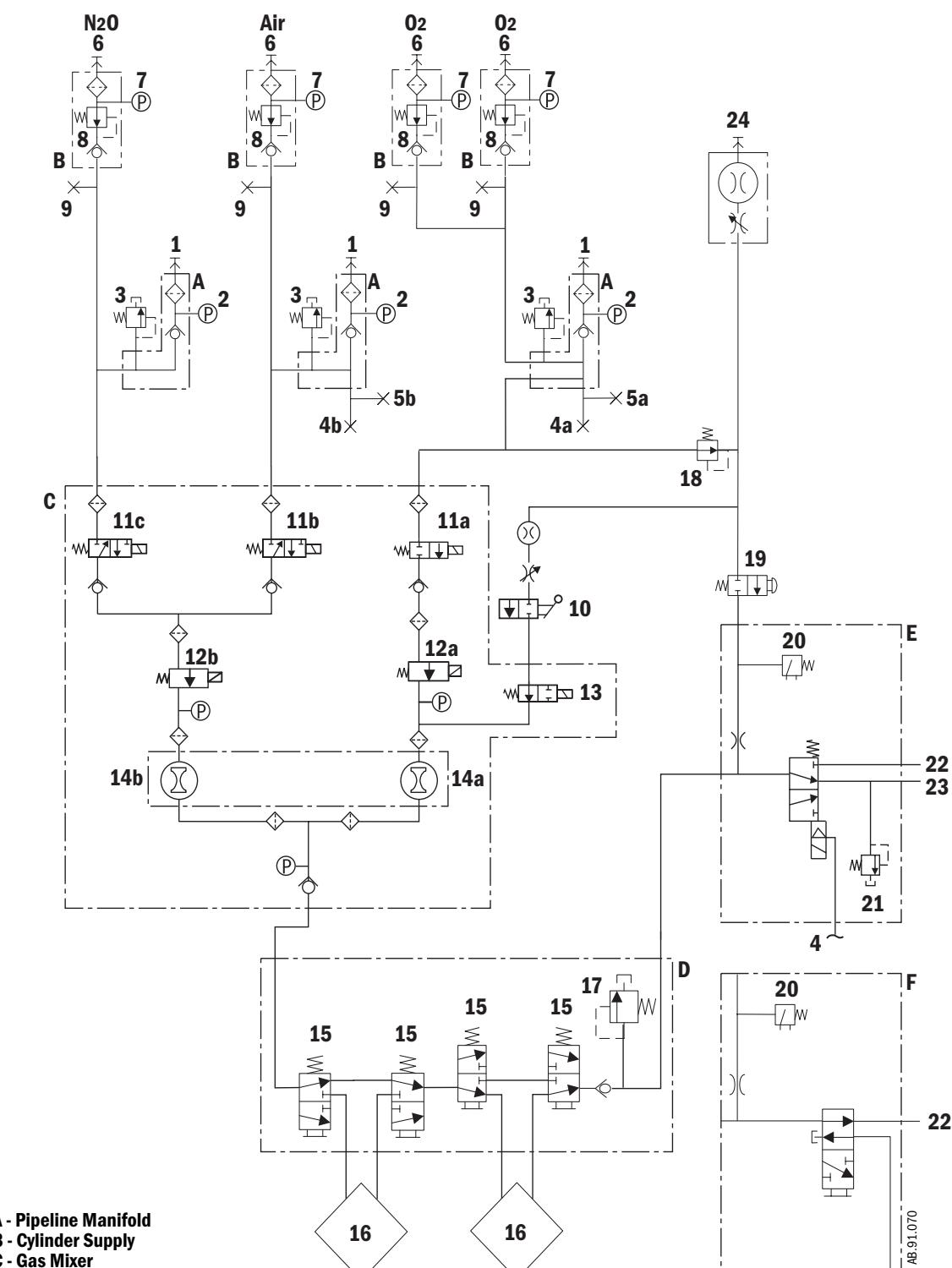


Figure 11-3 • Pneumatic circuit diagram

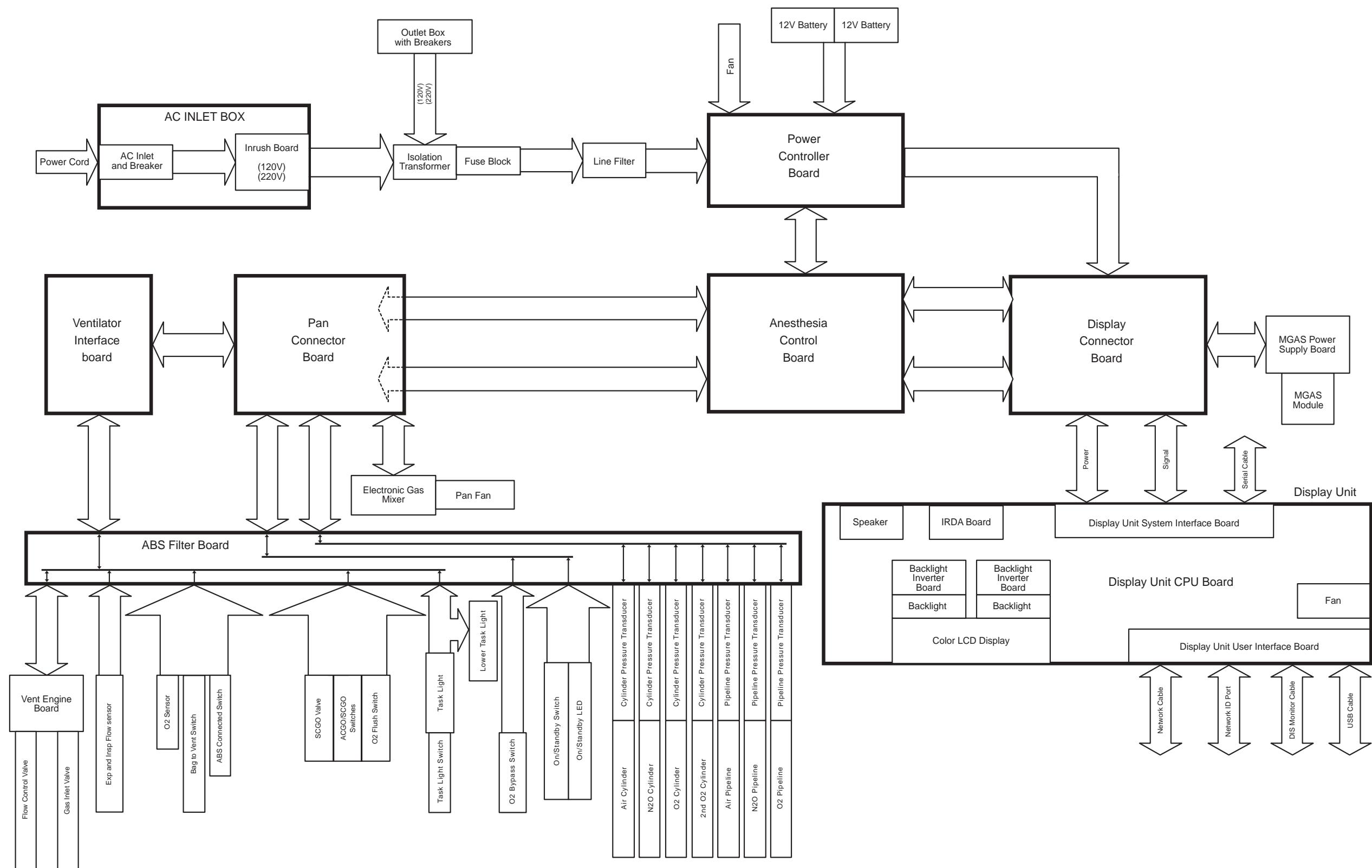


Figure 11-4 • Cabling block diagram

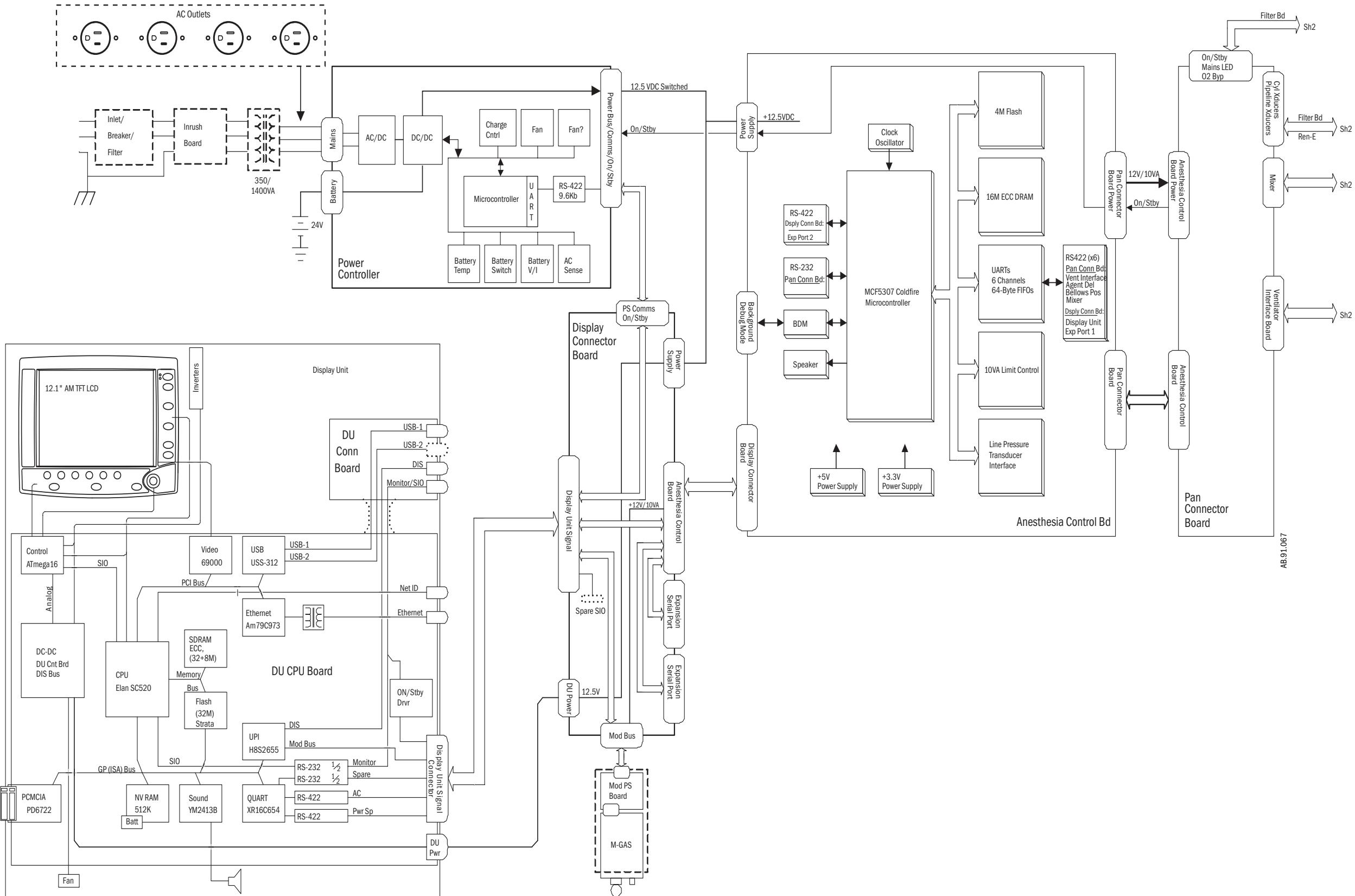


Figure 11-5 • System block diagram (sheet 1 of 2)

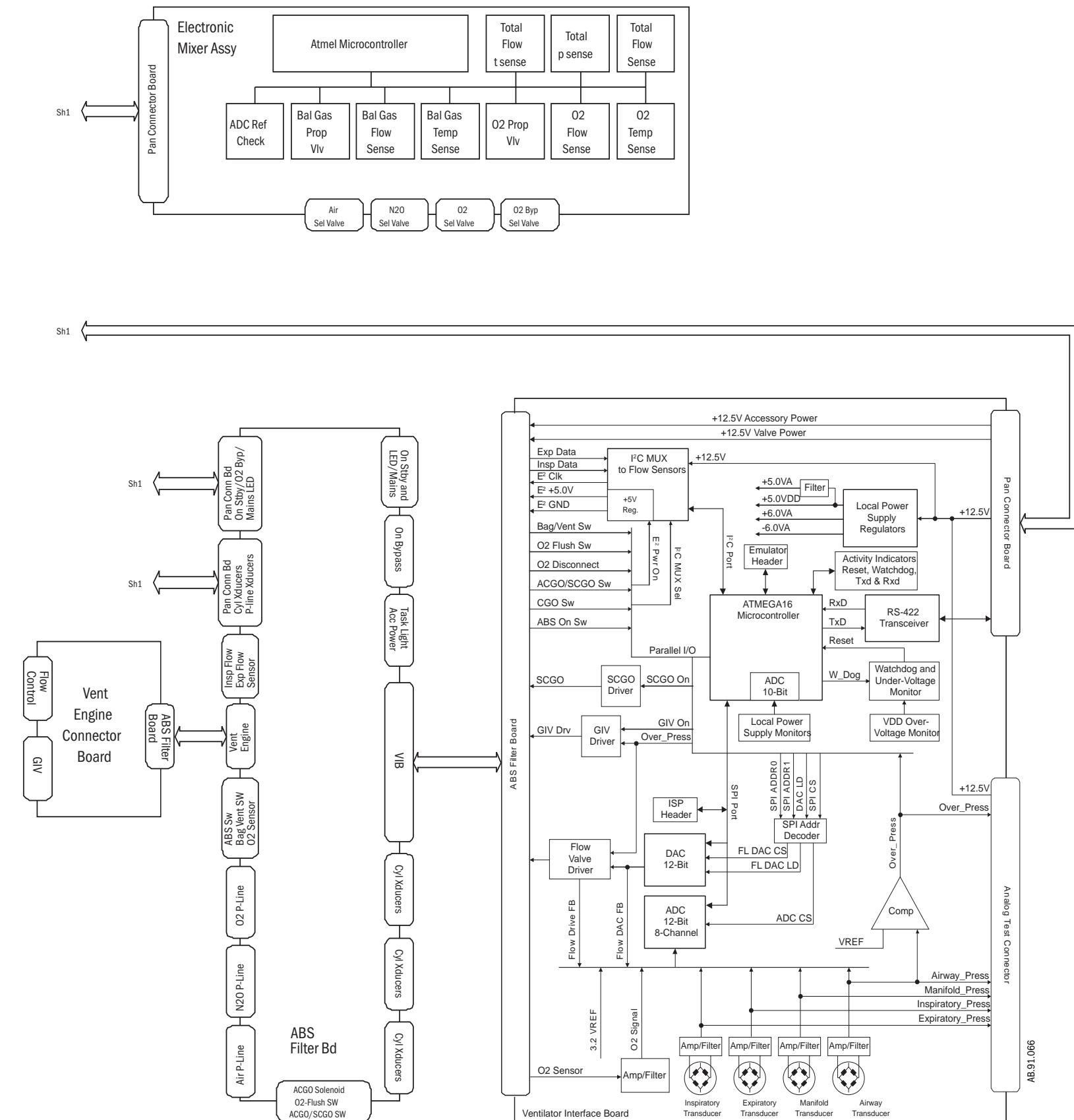


Figure 11-6 • System block diagram (sheet 2 of 2)

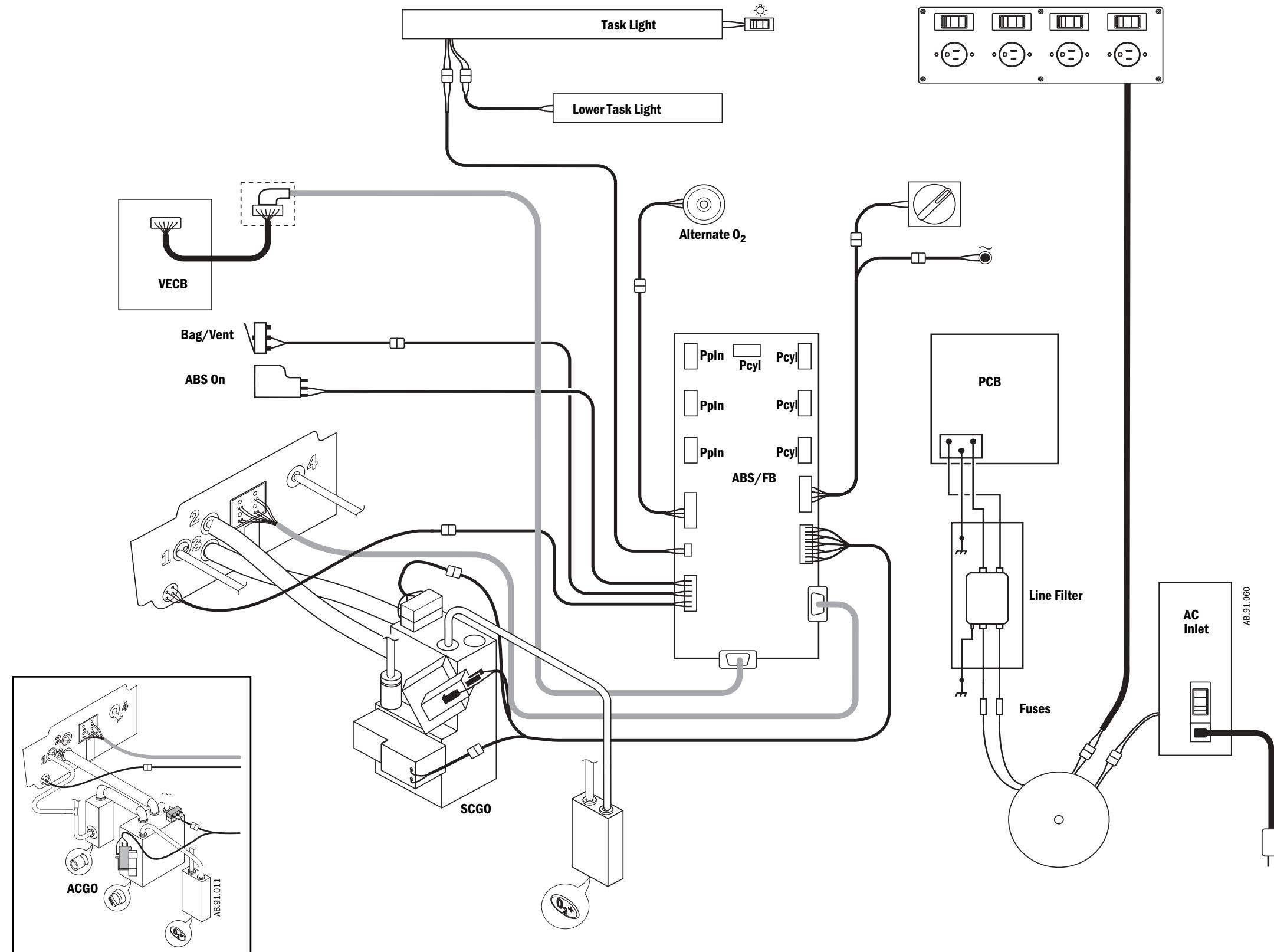


Figure 11-7 • Wiring harnesses

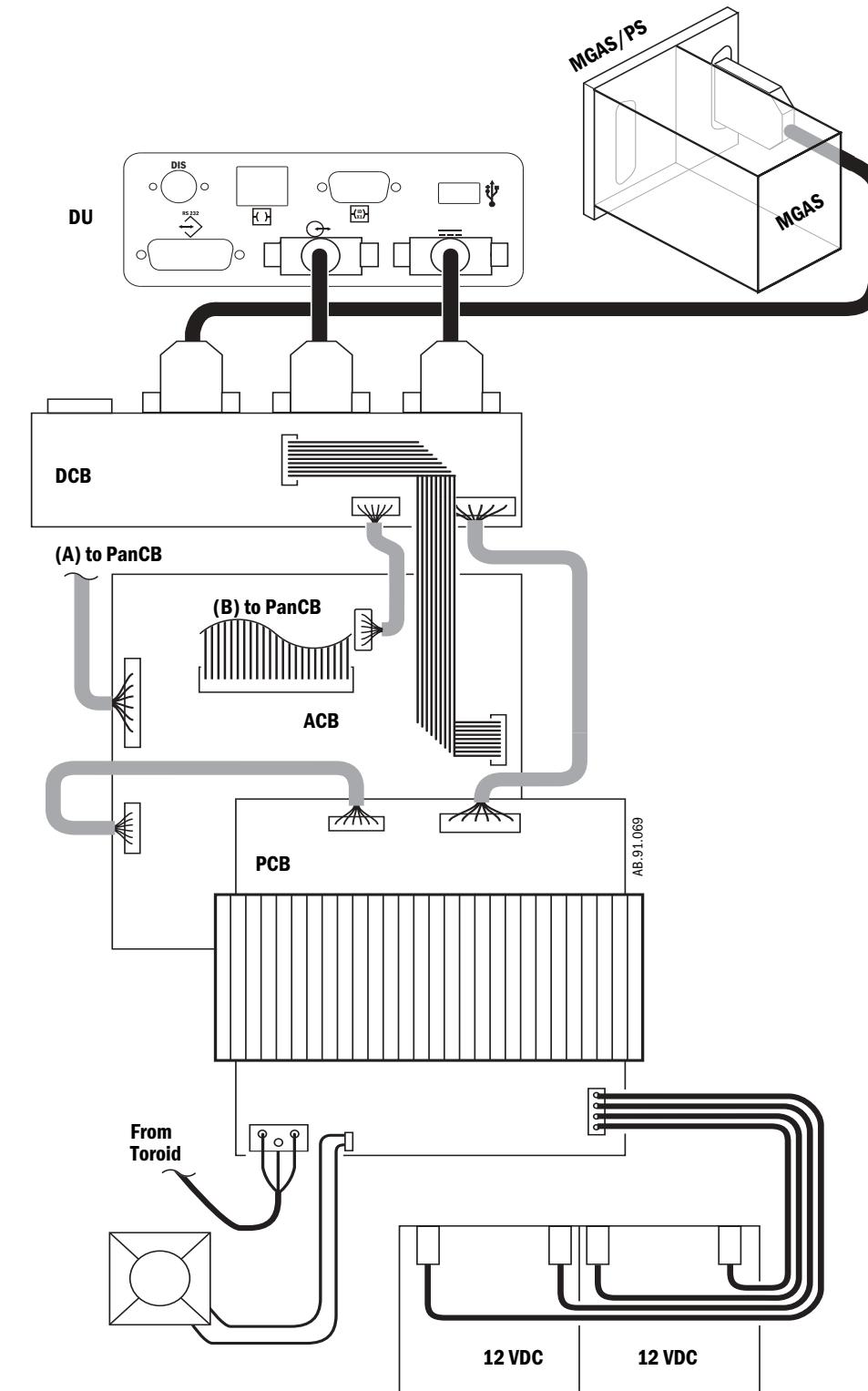
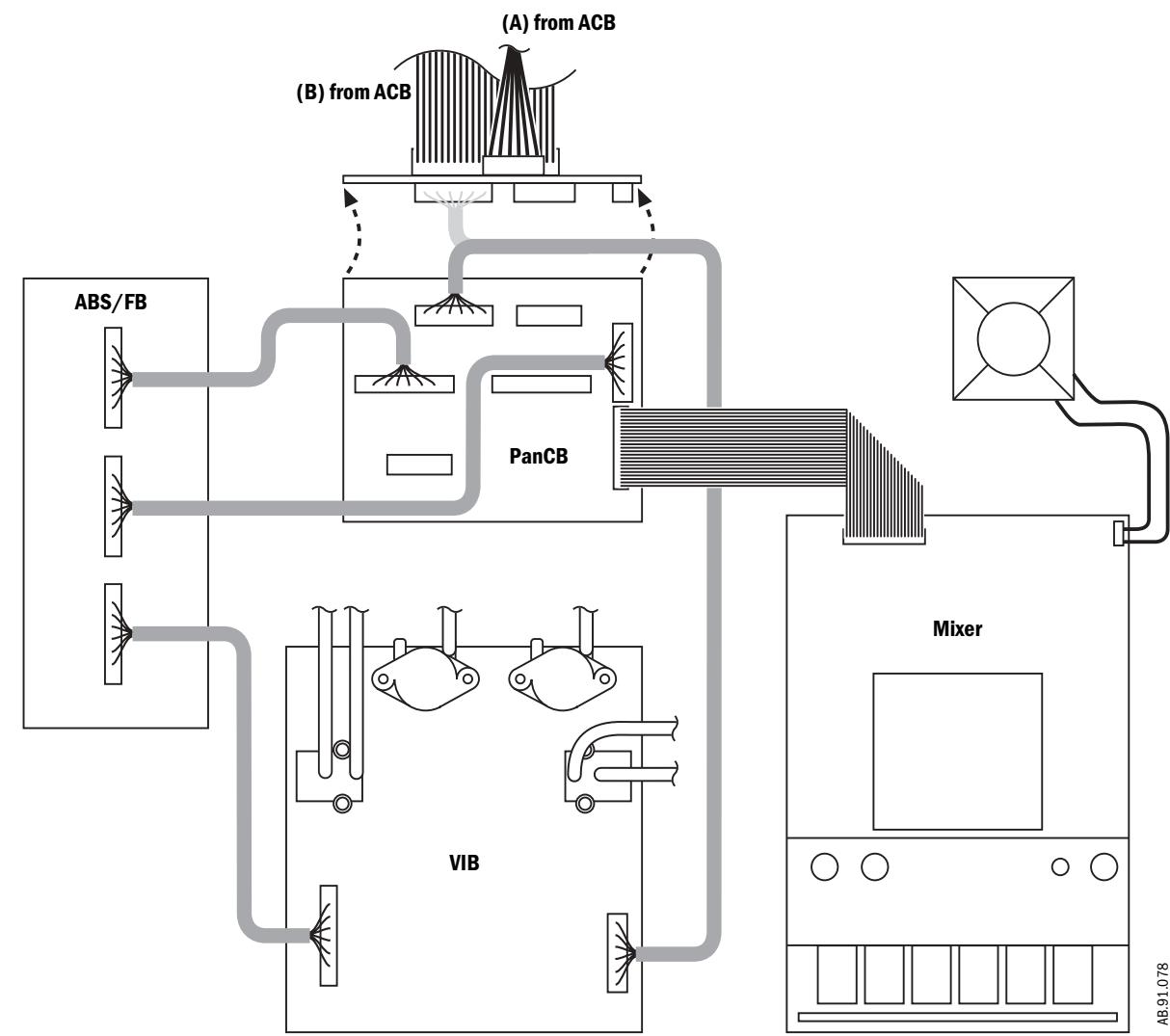


Figure 11-8 • Electrical cabling block diagram

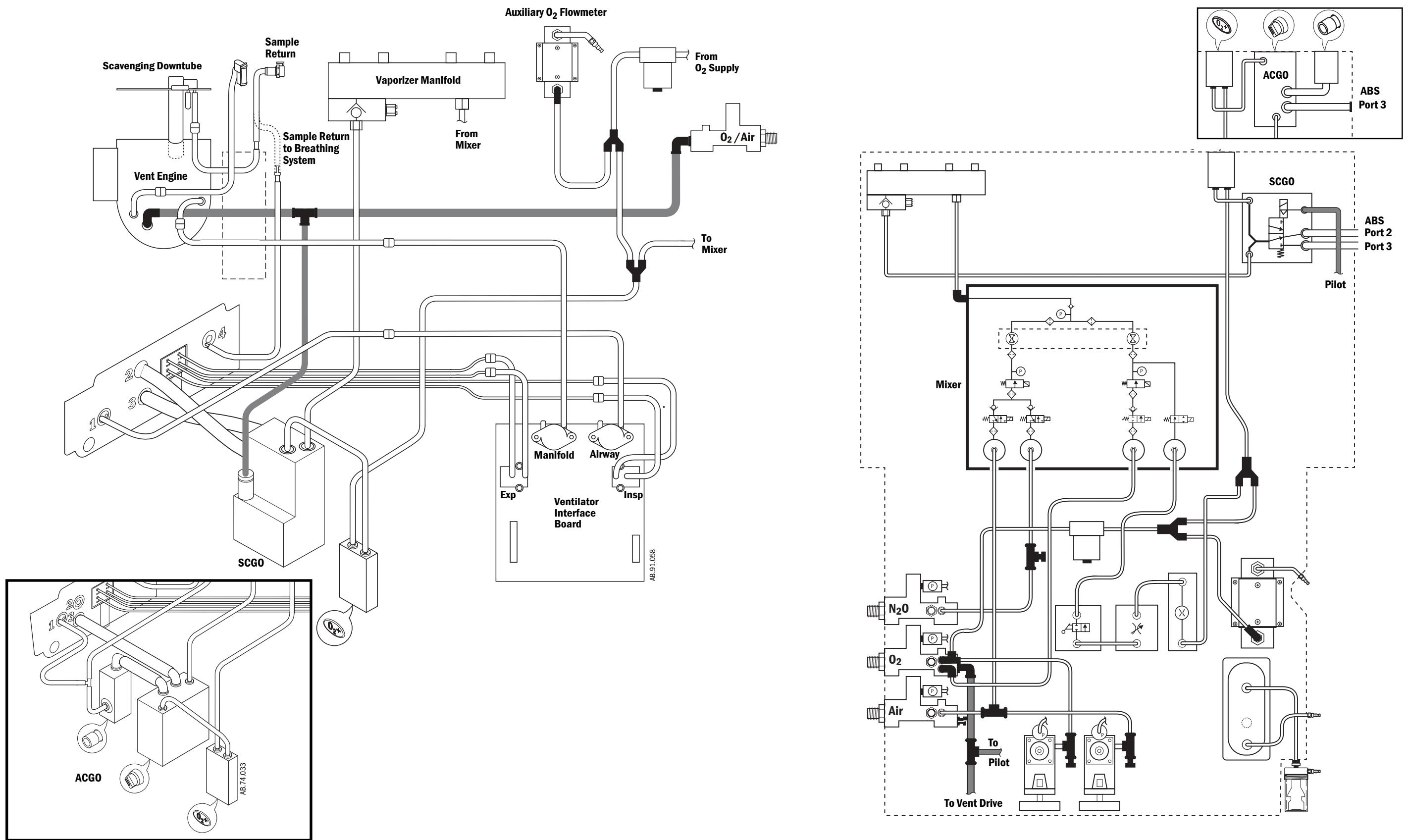


Figure 11-9 • Tubing

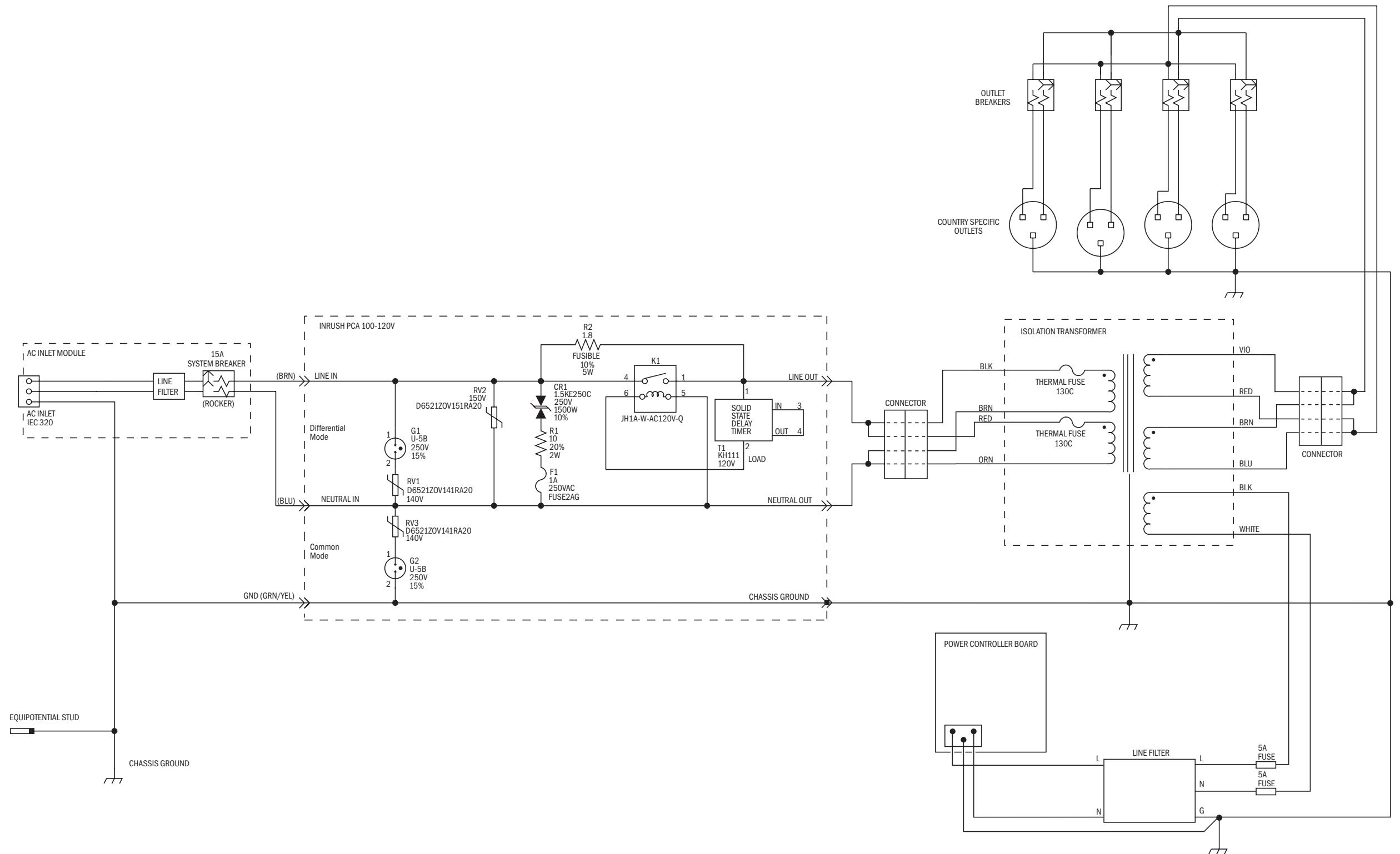


Figure 11-10 • Schematic, AC Inlet module; 100-120 V (with isolated outlets)

## Notes

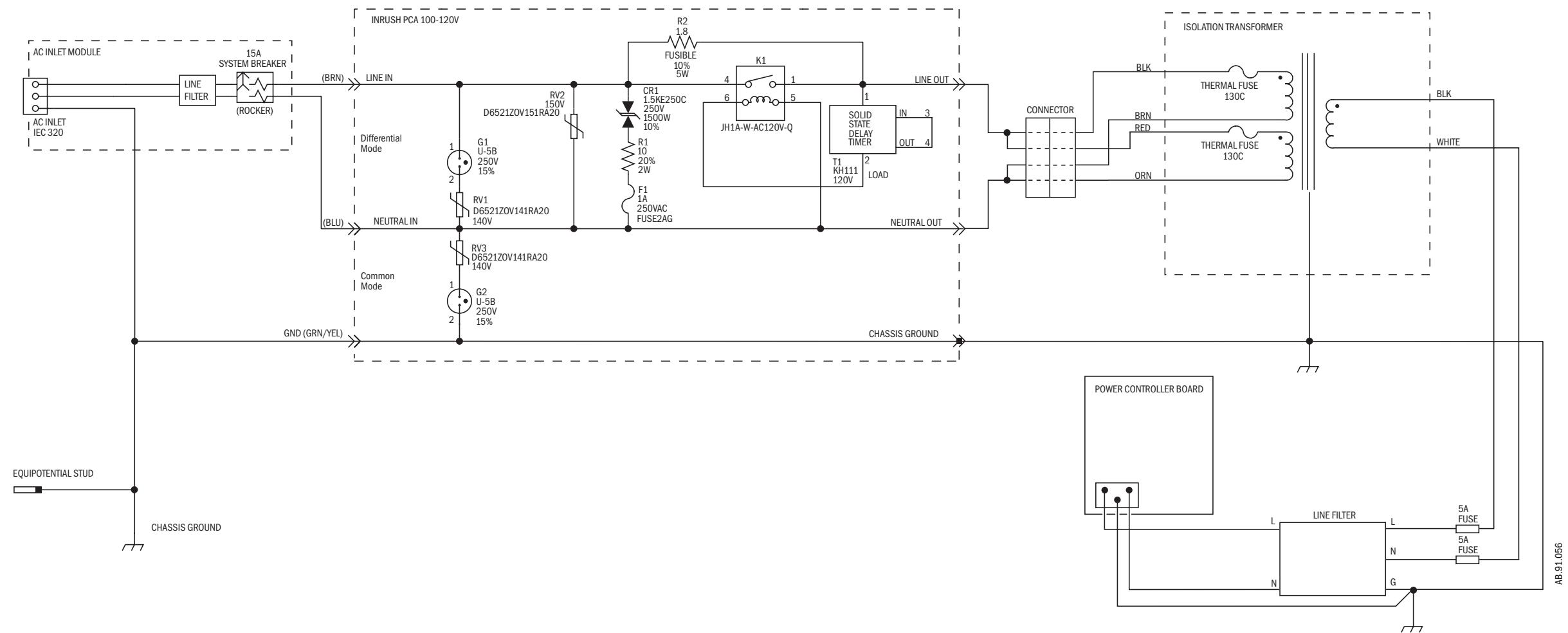


Figure 11-11 • Schematic, AC Inlet module; 100-120 V (no outlets)

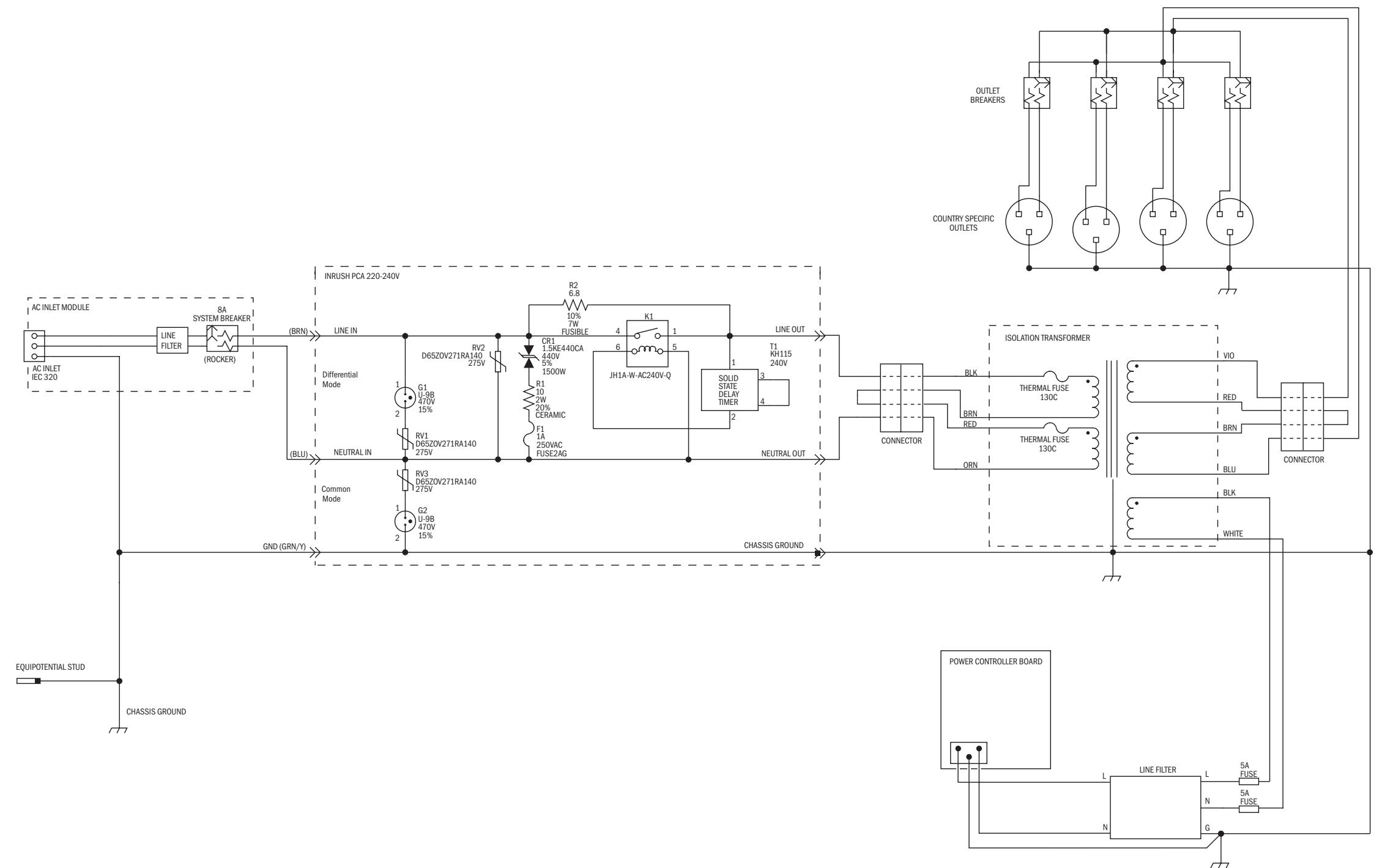


Figure 11-12 • Schematic, AC Inlet module; 220-240 V (with isolated outlets)

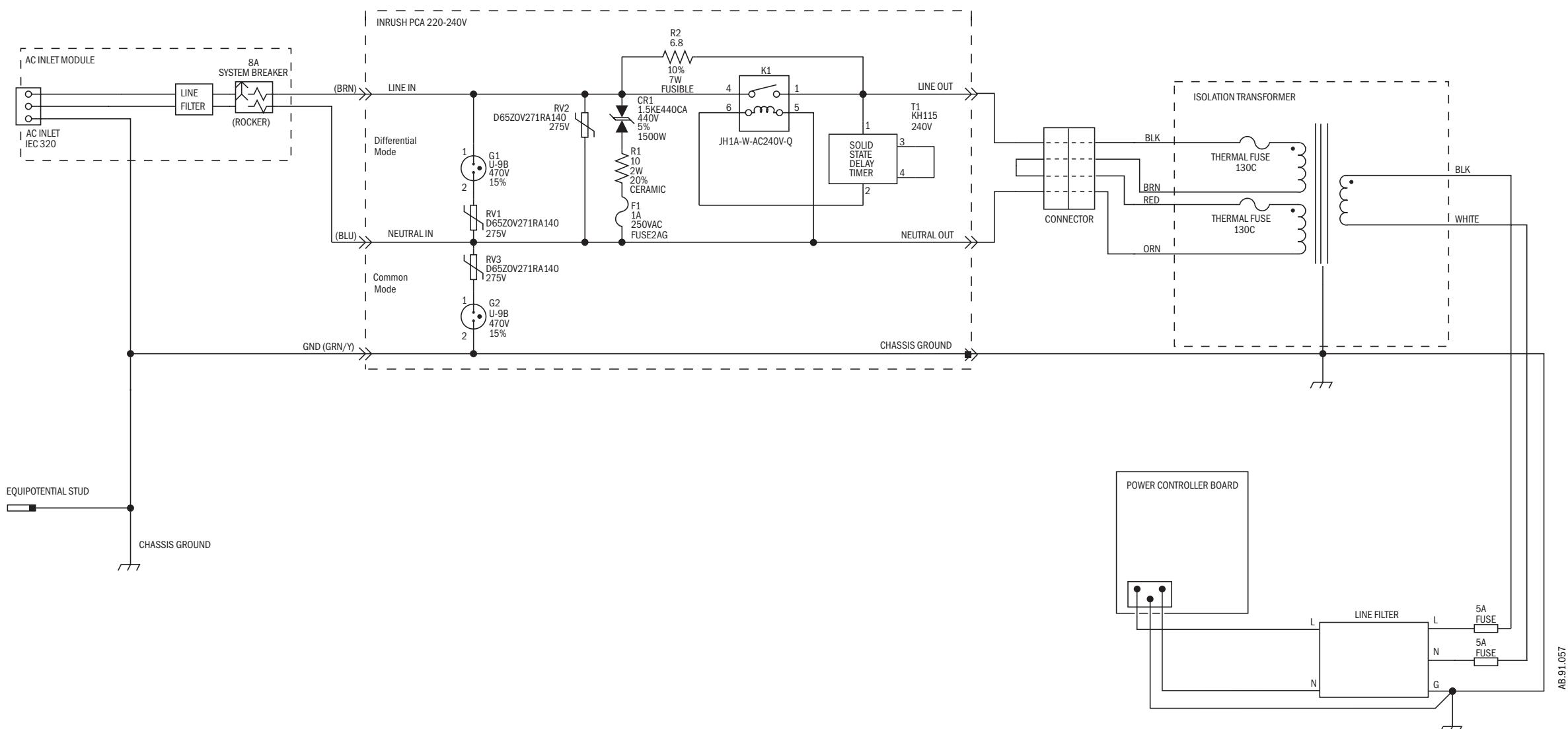


Figure 11-13 • Schematic, AC Inlet module; 220-240 V (no outlets)



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